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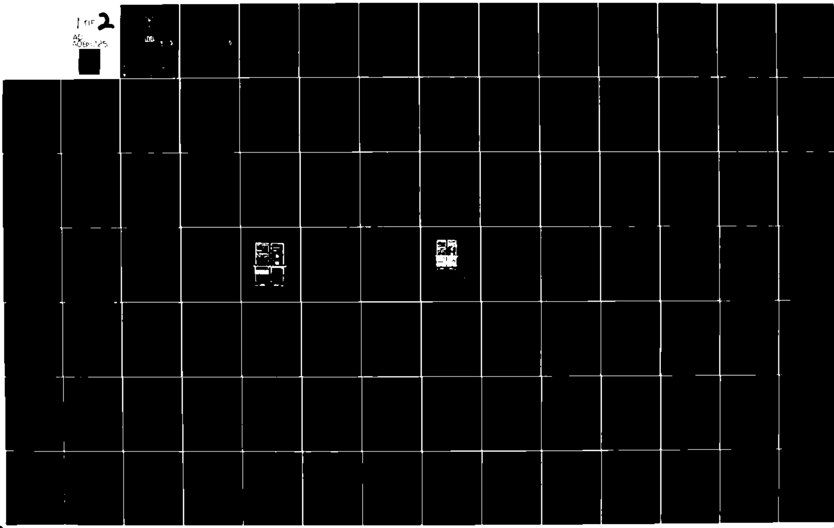

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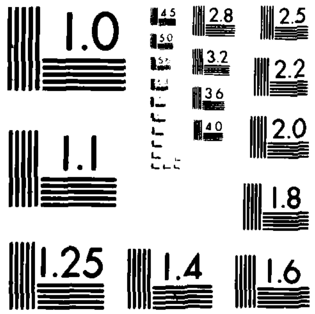

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VALIDATION OF THE OPERATING AND SUPPORT COST MODEL FOR AVIONICS AUTOMATIC TEST EQUIPMENT (OSCATE)

Joe Hernandez, Jr., GS-12

LSSR 46-80

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Thesis Chairman: Richard V. Badalamente, Lieutenant Colonel, USAF

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The operating and support cost model for Avionics Automatic Test Equipment (OSCATE) was previously developed primarily as an evaluation tool for use in ATE source selection and also in design trade-off studies. This thesis documents the results of the validation of this model. The sources of model data have been identified in detail in order to determine availability and ease future model use. A subjective evaluation of the model reveals it does represent significant operating and support costs and provides a means of evaluating available acquisition alternatives. Model limitations are discussed in terms of their impact on model use. Detail information on data sources, collection methods, and model use are contained in this thesis.

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VALIDATION OF THE OPERATING AND SUPPORT COST MODEL FOR AVIONICS AUTOMATIC TEST EQUIPMENT (OSCATE)

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

Joe Hernandez, Jr., BS
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And finally, thank you very much, Kathy Myers, for converting my virtually illegible drafts into this final product.

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CHAPTER I

INTRODUCTION

In the ever present reality of limited resources, large investments in weapon systems bring an attendant need for management control in order to maximize the return from dollars invested. A major portion of a weapon system life cycle cost (LCC) is the cost of operating and supporting the system over its lifetime. The LCC of a weapon system consists of the total cost of acquisition and ownership over the full life of the system. These costs are those of development, acquisition, operation, support, and (where applicable) disposal (70:2). The system operating and support (O&S) costs are generally greater than the acquisition price and may be several times this value (11:1). Weapon system support equipment (SE) constitutes a major portion of both the weapon system acquisition and O&S cost (16:2). For example, automatic test equipment (ATE) alone represent a significant investment, with expenditures presently running at over 1 billion dollars per year (16). This thesis is concerned with ATE costs.

In the United States Air Force (USAF), a significant quantity of various types of ATE is utilized to support operational weapon systems. ATE equipment encompasses

> . . . electronic devices capable of automatically or semi-automatically generating and independently furnishing program stimuli, measuring selected parameters of an electronic, mechanical or electro mechanical item being tested and making a comparison to accept or reject the measured values in accordance with predetermined limits. ATE may also include independently configured automatic or semi-automatic devices which are capable of detecting, measuring, and evaluating electrical/electronic or electro-mechanical characteristics of systems/equipment. ATE normally operates by use of previously prepared test software recorded on punched tape, card decks, magnetic tapes, disk pack or other storage media [53:1].

In the operational environment, ATE requires support in the areas of repair, spares, training, data, software, software support, maintenance, and management. The costs incurred by these support areas comprise the ATE O&S costs.

Design decisions made in the early system acquisition phases have a significant effect on all the system O&S costs (3:6) including ATE. LCC techniques, which consider these design decisions early in the acquisition process, can lead to significant reductions in system costs. LCC models serve to identify the associated cost component elements. The LCC model also identifies the contribution to LCC of these cost elements. The formulation of these cost elements is usually based on various system and equipment parameters and defines the relationship of these parameters to the cost elements (11:27). During the acquisition process, model application in evaluation of available alternatives in system and equipment parameters can lead to a reduction in LCC. Alternatives arise from various competing bidders, from different proposals from one bidder, or a combination of both of these sources. In actual use, LCC models have usually been "tailored for almost every specific application [1:1]."

Inherent characteristics designed into equipment, such as maintenance accessibility, reliability and standardization, either contribute to O&S costs or their avoidance (15:43). These characteristics are essentially determined during the initial design phases. This further emphasizes the need for consideration of the impact of design decisions made early in the system conceptual phase (7:7). The total value of O&S costs incurred by present in-service ATE highlights areas that need consideration in new designs.

ATE Acquisition Process

Major system acquisitions of ATE, as do all other major system acquisitions, consists of four major phases; conceptual, demonstration/validation, full-scale engineering development, and production and deployment (73:4-7). This process evolves from a continuing analysis of

> . . . those mission elements for which existing or projected capability is deficient in meeting the essential mission needs and to identify opportunities for the enhancement of capability through more effective and less costly methods and systems [73:5].

The Secretary of Defense determines these phases by sequential approvals.

The program manager is identified in the conceptual phase and establishes program objectives and acquisition strategies. The equipment performance requirements and constraints are specified for evaluation of alternatives. During the demonstration and validation phase alternatives are obtained and evaluated for adequacy. The more promising of these alternatives are selected for full scale engineering development phase, apart from the actual full scale engineering development, procurement of long lead time items and limited production to support the operational test and evaluation is also accomplished. The final phase, production and deployment, consists of full scale production and operational deployment of the selected alternatives (73:4-7).

During the conceptual phase of ATE, screening is accomplished of equipment available in USAF inventories (for which procurement data is available) that meet, or can be modified to meet, the defined requirement. This screening includes consideration of design, mission effectiveness and cost effectiveness on a life cycle basis. Equipment performance and calibration requirements are documented in a Test Requirement Document (TRD) (53:1). The TRD specifications are compared against a data bank containing in-service ATE specifications. If suitable in-service equipment is not identified, the following general design considerations are evaluated:

1. Design - automatic, semi-automatic, manual, digital, analog and/or combinations thereof.

2. Maintainability and reliability - modular, repairability, test point accessibility, calibration adjustments, connectors, cables, component location and layout, maintenance concepts.

3. Training - operator, intermediate and depot.

4. Software - standardization, development and support.

5. Transportability - fixed or portable.

6. Logistics support - spares required, complexity, special test equipment (STE) for maintenance and calibration, necessary data.

7. Other considerations - standardization and interoperability between NATO and other government organizations, standardization of common hardware.

During the demonstration and validation phase the following actions occur:

1. Evaluation of alternatives - validate adequacy, cost, need and long term software support.

2. Update of requirements - maintenance plan, and calibration support concept, and inclusion of this information in acquisition documents.

Resulting recommendations are included in the Decision Coordinating Paper (DCP) required for all major system acquisitions (72:3). This is a record of essential program information and the Secretary of Defense decisions directing the DOD component heads in the execution of this acquisition program (27:29).

The full scale engineering development phase consists of the following actions:

1. Design review - review equipment design, deficiencies, support equipment, calibration requirements, training, and data.

2. Acquisition process - long lead time production items, STE, calibration requirements, training and data.

3. DCP - update requirements.

The production and deployment phase consists of the following actions:

1. Production initiation - limited or full scale.

2. Training - develop formal training.

3. Management - transition of management responsibility from program manager to System Manager (SM).

Since design characteristics are largely determined early in the acquisition process, i.e., conceptual phase, LCC's are also essentially determined at this point (7:7). The need for management to control LCC's and their contributing factors is recognized by USAF implementation of the Integrated Logistics Support (ILS) program throughout the equipment life cycle, especially during its conception (6:59). One of the major objectives of this program is the reduction of overall system costs (47:2).

A recognized method of reducing costs is through the application of LCC techniques. The use of models is a major concept of these techniques (13:72). Various models have been developed to evaluate many aspects of LCC. Models vary in complexity due to their intended function. Some models only sum the applicable cost elements while others may determine cost elements in relation to design parameters (10:1). Models which determine cost elements in relation to design parameters are best suited for application during the acquisition process. This can be an effective tool which the program manager can use in evaluation of the cost impact of available alternatives.

The Operating and Support Cost Model for Automatic Test Equipment (OSCATE) was developed in 1979 by the Research Team of Guerra, Lesko, and Pereira to "help program managers forecast SE requirements, estimate budgets and schedules, and perform trade-off analyses (21)." This model is designed to estimate and measure O&S costs of Avionics ATE for use in LCC analyses (12:2). O&S costs are estimated by a set of mathematical equations which encompass various O&S elements over a specified period of time (12:24).

Statement of the Problem

The Aeronautical Systems Division (ASD) SE Systems Project Office originally sponsored the development of the

OSCATE model for use by their program managers during the acquisition process (12:5). This is based on a DOD (71:3) and Air Force (49:1) requirement to acquire systems that provide the lowest feasible LCC while satisfying operational needs. This effort was also sponsored due to high level attention given to SE acquisition management problems and high dollar investment (21).

A fundamental concern in the formulation of any model is its adequacy in evaluating a specific application. The model should provide a representation of a real world process that describes the logic and relationship between elements of the process (5:2). In the case of an O&S model it should provide a representation of the component O&S costs associated with a particular acquisition process. Model validation involves measuring how well the model represents the real world. In this case, validation involves input of historical data into the model and computing the resultant O&S costs. The computed costs should then be compared to the actual incurred costs. The SE Systems Project Office recognized the need for model validation when initially sponsoring this model development effort (21).

Since model validation was not accomplished during development, there exists a need to validate the OSCATE model. This was further acknowledged by the Guerra, Lesko, and Pereira research team in their research recommendations (12:109).

Research Objectives

A major portion of this validation effort will involve the identification and collection of the historical data needed for model implementation by program managers during the acquisition process. Actual incurred costs for each of the model cost equations must also be obtained for use in comparison of model predicted (computed) and the actual costs.

Consequently, the objectives of this research effort are:

1. To determine the data base needed to implement the OSCATE model, and

2. To determine the accuracy of the OSCATE model by comparing predicted (computed) with actual incurred O&S costs.

Research Questions

The nature of this model validation effort gives rise to the following research questions.

1. What data are necessary to exercise the OSCATE model?

2. What additional data are necessary to accomplish the cost comparisons necessary for validation?

3. What are the sources of the needed data?

4. How must the needed data be extracted or obtained from the available source?

5. How accurately does the OSCATE model estimate actual O&S costs of ATE?

CHAPTER II

BACKGROUND ON OSCATE

The OSCATE model was developed to estimate and measure O&S costs of avionics ATE. Development was sponsored by the SE Systems Project Office, which felt the model could be useful as an aid in source selection, and defining incentive goals and other contract guarantees during the acquisition process (12:41). This model could be one component of a total LCC model, or the only model used in a system acquisition process based on LCC.

OSCATE was developed as an additive accounting type model, since this type was considered most appropriate for its intended uses (12:41). Accounting type LCC models define an orderly method of summing life cycle cost components (8:17). The OSCATE model defines the ATE O&S cost components in several separate equations.

OSCATE Model Cost Elements

The cost elements identified by the individual equations are:

1. Cost of Test Repairable Unit (TRU) spares (C_1).
2. On-Equipment Maintenance (C_2).
3. Off-Equipment Maintenance (C_3).

4. Inventory Management Cost (C_4).
5. Cost of Support Equipment (C_5).
6. Cost of Personnel Training (C_6).
7. Cost of Management and Technical Data (C_7).
8. Calibration Requirements (C_8).

Logistics Support Cost is represented by the sum of these factors; e.g.,

ATE Logistics Support Cost = $C_1 + C_2 + C_3 + C_4 + C_5 + C_6 + C_7 + C_8$

The following is a brief description of the cost factors represented in the model (12:27-29):

Cost of TRU Spares (C_1)

Cost of spares to fill the field and depot repair pipelines and replacement of condemned items.

On-Equipment Maintenance (C_2)

Cost of servicing, preventive maintenance, time change removals, unscheduled removals, and time expended during fault isolation.

Off-Equipment Maintenance (C_3)

Cost of repair of subassemblies after removal when a failure has occurred.

Inventory Management Costs (C_4)

Cost of new inventory life cycle management based on quantity of spares estimated.

Cost of Support Equipment (C_5)

Cost of acquisition of SE for ATE.

Cost of Personnel Training (C_6)

Cost of maintenance personnel training over life cycle.

Cost of Management and Technical Data (C_7)

Cost of data collection for maintenance actions and the acquisition and maintenance of technical data.

Calibration Requirements (C_8)

Cost of all ATE calibration required.

Model Assumptions and Limitations

The following are assumptions and limitations used in model development (12:25-26,38,43):

1. Each ATE using base is fully operational.

2. The level of program activity determines the spares requirement.

3. Repair locations are limited to one Technological Repair Center (TRC) and several intermediate repair shops.

4. Only follow-on training for maintenance personnel is considered.

5. Certain contributing costs are not included due to difficulty in obtaining, or unavailability of cost data.

6. The model development effort only considered for inclusion variables which collectively contributed approximately 80 percent to the actual operating and support cost.

7. The contractor will be provided the weapon system First Line Unit (FLU) testing requirements and no TRU would be repaired at field level.

Model Development

The following were the steps used in the model development (12:43):

1. Identification of the variables.

2. Grouping of the variables into categories.

3. Determining relationships to obtain the category equation.

4. Combining all the categories for a total O&S cost. All cost elements, except Calibration Requirements (C_8), were derived from modification of equations in the AFALD/XRSC Logistics Support Cost model Version 1.1 (12:88). The Calibration cost element equation was derived through dimensional analysis.

Model Developmental Analysis

The OSCATE model is programmed into the AFLC CREATE computer system. During model development, data was collected or estimated for input into the model. This data provided a means of evaluating the sensitivity of the model to variable changes. Variables selected for sensitivity analysis were those which were thought to be controlled by the contractor during equipment design. Model sensitivity analysis using the selected variables revealed different model responses. This was thought to be caused by model structure, assumptions and data base accuracy.

Model Development/Research Results

The major conclusion presented in the Guerra-Lesko-Pereira research was that the model has a potential for use in ATE acquisition (12:102).

Based on their research results, the following recommendations were made (12:109):

1. Model validation is required.
2. Develop an equation (C_9) for software.
3. Test assumptions regarding availability of ATE.
4. Establish a data system to provide data for the model.

To accomplish the recommended validation, a specific procedure for validation was developed in this thesis.

CHAPTER III

METHODOLOGY

The OSCATE model has been developed for use by program managers to evaluate the impact of ATE system parameters on LCC. In using models for this purpose, the program managers should examine the model in terms of four basic characteristics: completeness, sensitivity, validity, and availability of input data (7:31). Completeness refers to the inclusion of as many O&S cost elements as are necessary for the decisions that will be made based on the model results. Sensitivity is necessary so that the model results will reflect differences in system parameter alternatives under evaluation. Validity refers primarily to user confidence that model output is reliable and sufficiently accurate. The availability of input data is of paramount importance, since model usage is based on data input (7:31). The characteristics of completeness and sensitivity were addressed during model development. The process of validation and the identification of the sources of input data are the focus of this research effort.

The general model validation process may be objective and/or subjective in nature (4:21). This validation process was objective and was intended to involve three phases: data collection, data input into the model, and a determination of the model's accuracy in estimating actual O&S costs. Data collection was accomplished with a view toward the data needed for input into the model and data for evaluating model results.

A multitude of data systems exist which contain voluminous quantities of data. Each data system is designed to fulfill a particular data collection goal. The contents of each data system is a collection of detailed data of a specific aspect of a functional area. For example, within the functional area of supply exists an intransit control (data) subsystem. Each data system usually contains a number of data reports that display portions of the data system detail data contents known as data elements. Two of the many report formats available in the intransit control (data) subsystem are the unserviceable returns report and the order and shipping time report. The various reports in a data system are output at specific time periods, such as daily, weekly, biweekly, etc., or on demand. Each output report covers a specific time period portion of the data collected and available in the data system. The large number of data systems and reports available presents a formidable challenge in the collection of historical data for the accomplishment of model validation.

The OSCATE model contains eight cost equations representing groupings of different contributing costs such as costs of component spares and system calibration. This dictates the need to research existing data systems to determine if the data elements comprising the contributing costs are available. If the data are not available in the data systems, historical documents in the office of primary responsibility (OPR) for that functional area must be researched for the data. Once the data are found to be available, it must be extracted and compiled for input into the OSCATE model. Depending on the source and type of data, the extraction process can take on one of many forms varying from manual copying of data from historical documents to manipulation of computer data storage tapes by computer program. The difficulty of this extraction process is compounded by the fact that the various data reports are output for time periods of varying lengths. This may then require, for a specific time period, data extraction from monthly reports for certain data and quarterly reports for other data. In some data systems a report may only be available in a calendar year summary format. The collected data must also be analyzed to determine if it does, in fact, represent the needed data, since even though the nomenclature in the data system and model may be identical, the data elements may represent different things. The complex steps described above dictate the need for their meticulous accomplishment which in turn raises the probability of procedural difficulties. This is exemplified by the need to order the items being researched in the ordering sequence of the particular data systems. The ordering sequence usually varies from system to system and almost from report to report within a data system.

Data Collection

The data collection phase was directed toward identifying the required data, the available data, and the method of extracting the required data. The accomplishment of any one aspect of data collection was highly dependent on the accomplishment of one or both of the other aspects. Figure 1 summarizes the data collection procedure employed.

Required Data

The required data was identified from the model equations and variables. The equations and variables were analyzed to determine the accuracy and clarity of definitions and the dimensional units of the required information. In the analysis of the definitions of the equations and variables an attempt was made to eliminate any ambiguities or interpretational difficulties that might arise in model implementation. The required data dimensional units were determined to insure that the correct data was used for input into the model and comparison of results.

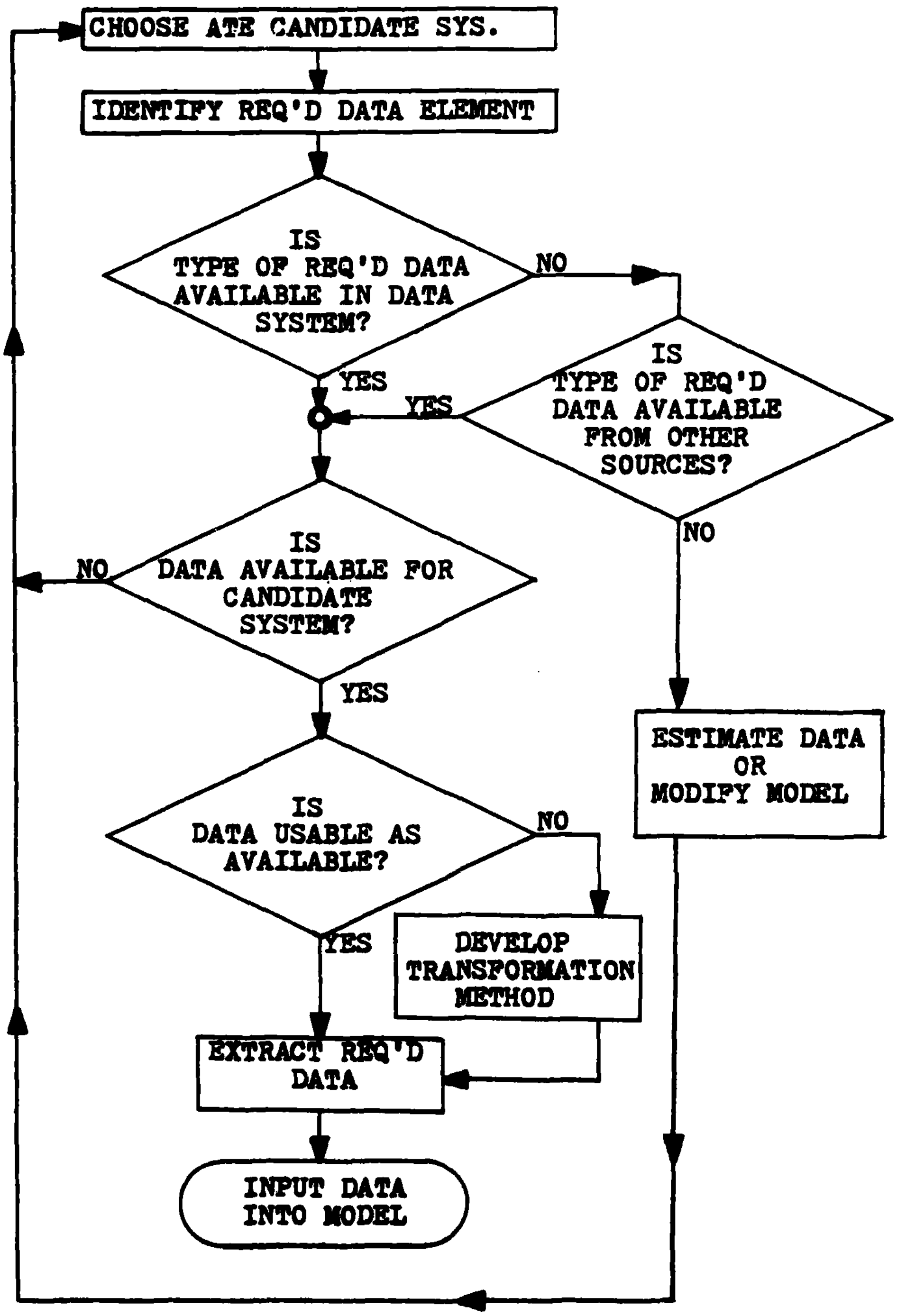

FIGURE 1. DATA ELEMENT SEARCH PROCEDURE

Since a number of variables are used in several of the cost equations, grouping of the variables into related classes, such as base level, depot level, training, etc., was accomplished. This helped simplify the data research effort by emphasizing the specific data required from various related areas.

Available Data

Much of the data available in USAF data systems are based on the Maintenance Data Collection (MDC) system which originates at base level. The MDC system collects data initiated by the working level technician (13:82). These data are collected by Work Unit Code (WUC) which is a five-digit alphanumeric code that identifies systems, major assemblies, or individual components (14:24). Data are then provided to management at various levels in the USAF (13:82). This results in numerous reports reflecting different kinds of information. Since data were needed from different categories (levels) and of different types, collection was necessary from many different reports.

Another major source of input data into many of the USAF data systems is that of depot level repair and item management information. These data are input by National Stock Numbers (NSN), Equipment Specialist (ES), and Manager Designator (MGR DES) codes.

Each data system within the USAF is assigned a data system designator (DSD). For each data system the assigned DSD consists of a letter prefix and three or four digits, for example D041. The letter prefix denotes the function supported by the data system such as the previous example's letter designator of D indicates it supports the Materiel Management function (23:1). This allowed cross referencing between data systems supporting specific functions and model variables pertaining to a particular function.

In the event required data were not available in a formal data system, other management and technical documents such as regulations, technical orders, and various management reports were researched. If data were still not directly available, it was estimated from available data (if possible). If estimation was not possible or practical, the model would have to be modified. Each case of data estimation is identified and analyzed in subsequent sections. Model modification was not found to be necessary.

Extraction of Data

Since data was needed from a number of different reports, it was necessary to determine what data was needed to research or obtain data system output. This involved the identification of various codes such as WUC, NSN, ES, and MGR DES. The codes were then put in the ordering sequence as they should have been listed in the respective system. In addition many reports used more than one code for the ordering sequence. One report listed data by IM code and then for each code the data was listed by NSN. This required research of a considerable amount of information prior to research of the various data systems for the required data.

Extraction of the required data took on many forms. Most common was manual research of historical data reports recorded on microfiche cards. A paper copy was then made of the required data. Another common form was manual research of historical files of paper copies. In each case, the form of data extraction employed was the most readily available.

Additional Considerations

The complete data collection process was preceded by a preliminary data research process. This preliminary process was accomplished to choose a candidate ATE system for which validation could be performed. The initial step was to choose an ATE system for which data was probably available in all applicable data systems. Lack of data could occur due to reasons such as lack of reporting of maintenance actions and subsequent deletion of reporting codes such as WUC. This also involved consideration of the candidate systems representativeness of in-service ATE systems, major modifications in progress or planned, and extent of usage on different weapon systems. These considerations were directed at choosing a manageable candidate ATE system for accomplishing the data collection process.

Data Input into the Model

The second phase of model validation consisted of input of the collected data into the OSCATE model and computing estimated O&S costs. The collected data required formatting for input into the OSCATE model computer program. The program requires a specific data input format for proper model computations. A description of the required input format was developed and is contained in the next chapter. The resulting computed costs are clearly labeled on the computer outputs of Appendices G and H.

Determination of Prediction Accuracy

The computed costs resulting from the data input were to be compared against the cost equation historical data collected. This would have resulted in an evaluation of the models' ability to estimate O&S costs. Difficulties encountered in the collection of cost equation historical data is discussed in the next chapter.

CHAPTER IV

THE VALIDATION PROCESS

Introduction

At the outset of this validation effort it became evident that a number of interrelated tasks would have to be accomplished. In order to ease this effort as a whole, it was separated into several components that were more manageable. These components consisted of an evaluation of requirements, candidate system selection, data sources and systems search, data collection for the variables and equations, exercising the model, and an evaluation of the results obtained. The data collection for the variables and equations was further separated into four components: collection of data for the government furnished variables, subsystem variables, TRU variables, and equation costs. The results obtained from these tasks are discussed in the following sections.

Evaluation of Requirements

This validation process required the collection of data for the variables and equations. The data collected for the variables must be formatted for input into the model. This required the collection and review of a large quantity of data. The model requires input of data for 80 individual variables and of these, 55 usually require input of multiple values due to the several subsystems and TRU's of the ATE under evaluation. Even though the LSC model has been applied in acquisitions, a "road map" of the sources for the individual variables and equation costs was not available. If available, it would have greatly simplified the data collection effort due to the commonality of a number of variables. The necessary "road map" was developed in this validation effort as described in the following sections in order to provide an insight into the availability and sources of the required data.

The data collection task was accomplished as outlined in Figure 1. The output of this task, the collected data, provided the input for the subsequent components of the validation process and are shown in Figure 2. Once data for all the variables was collected, they were assembled into the required format for the OSCATE model computer program. This required separation into system, subsystem, and TRU variables as shown in the input block of Figure 2 to the OSCATE model. Once input, the data was processed by the computer model and the resulting output is a computed total logistic support cost and its component costs. The total logistic support cost consists of the sum of the eight individual equation computed costs.

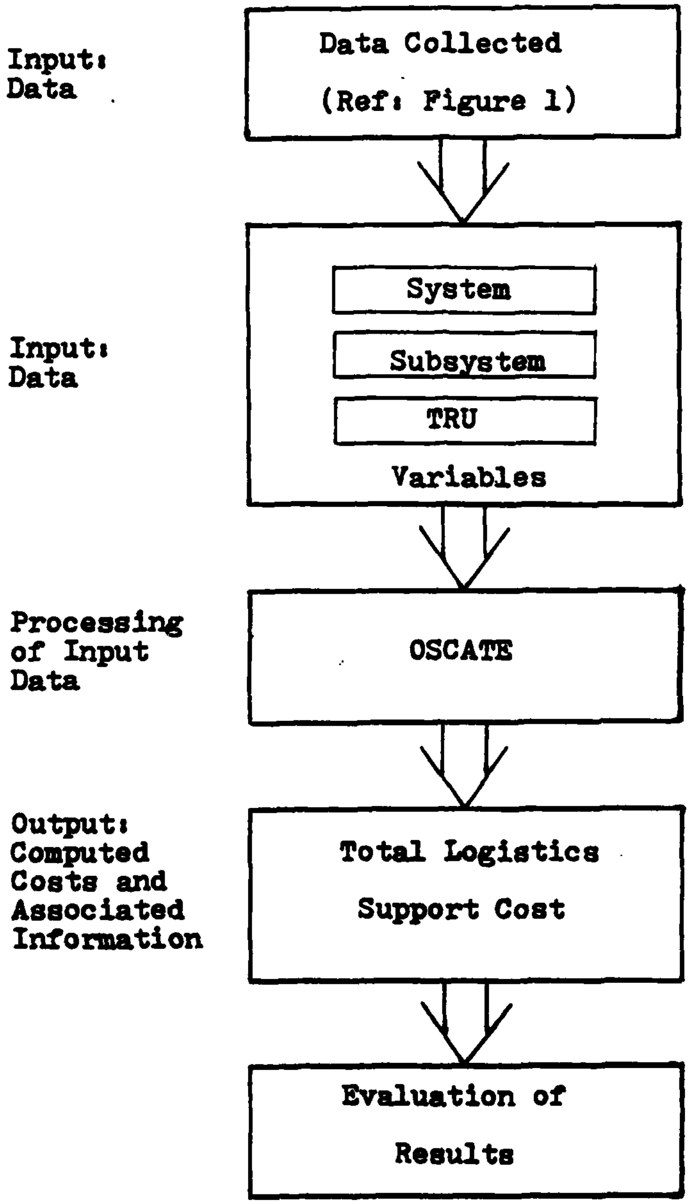

FIGURE 2. DATA FLOW AND PROCESSING

Evaluation of the model revealed certain structural limitations. These limitations are described in the discussion of the individual variables in the subsequent sections.

Throughout the validation process it was evident that model users should be familiar with the model and ATE in general in order to fully appreciate model useability. The model may appear rather formidable on first impression due to its structure and quantity of variables. However, the model is easily tamed after examination and some familiarity is achieved.

Candidate System Selection

The candidate system selection step serves as the starting point for the data element search procedure. Candidate system selection also requires a number of considerations in terms of use of the system in model application. For an acquisition application, the candidate system should be representative of the system being acquired. For example, if an F-16 avionics intermediate shop (AIS) system were being procured, a representative candidate system might be the already operational F-15 AIS. This raises another important consideration, that of the availability of data. A relatively new system may not have been operational for a sufficiently long period of time to have available sufficient data in the various data systems used as data sources. This was found to be the case with the initial candidate system, the F-15 AIS computer test station. It was found to have only a sparse amount of information available on depot overhaul costs. This was due to the newness of the system which had caused an insufficient quantity of reparable assets being generated for depot repair. The use of a recently operational candidate system may also reflect increased repair and maintenance costs from an increased number of failures due to infant mortality and initial set up and deployment. The choice of a candidate system that is near the end of its operational life may also reflect increased costs due to an increased number of wear-induced failures. Increased costs may also be caused by repairing failures at any cost due to the lack of replacement parts and the need for the ATE to remain operational.

Another important consideration was revealed in the selection of the A-7D computer programmer set as a possible candidate system. The Navy has item management responsibility for this piece of ATE. Thus, item management and depot overhaul cost data was not available in Air Force data systems. This data is available through comparable Navy data systems, but would have compounded the already sizeable data collection effort. Another consideration concerns peculiarities occurring in equipment usage, modifications accomplished, increased or decreased weapon system LRU workloads programmed for the ATE, or any other operational peculiarity that may reflect abnormal costs in the available data. Lack of (or a low volume of) maintenance data reported against assigned equipment WUC's may cause the deletion of these WUC's from Technical Order (TO) 51-1-06-1 (68) and thereby cause the loss of this important data source.

Two candidate pieces of ATE were chosen for data collection. These were the F/FB-111 weapon system Central Air Data Computer (CADC) test station (NSN: 4920-00-460-0397DQ, WUC: PAJ00) and the Punched Tape Reader Type AN/GYQ-9 (NSN: 4920-00-764-0128DQ, WUC: PAL00). The CADC test station, shown in Figure 3, provides the means to perform intermediate level maintenance testing of the following F/FB-111 weapon system line replaceable units (LRU's): CADC, maximum safe mach assembly (MSMA), pressure sensor, and the engine pressure ratio transmitter (EPR XMTR)(38:1-1). This tester was chosen as representative of in-shop ATE units. The size of this tester (two equipment bays) did not pose an overly large data collection effort.

The tape reader, shown in Figure 4, is used to enter data into the general navigation computer (GNC), or the AGM-69A computer, and can be used at the organizational or intermediate levels of maintenance (62:1-1). This tester was chosen as representative of the smaller pieces of ATE and also provided a manageable data collection effort.

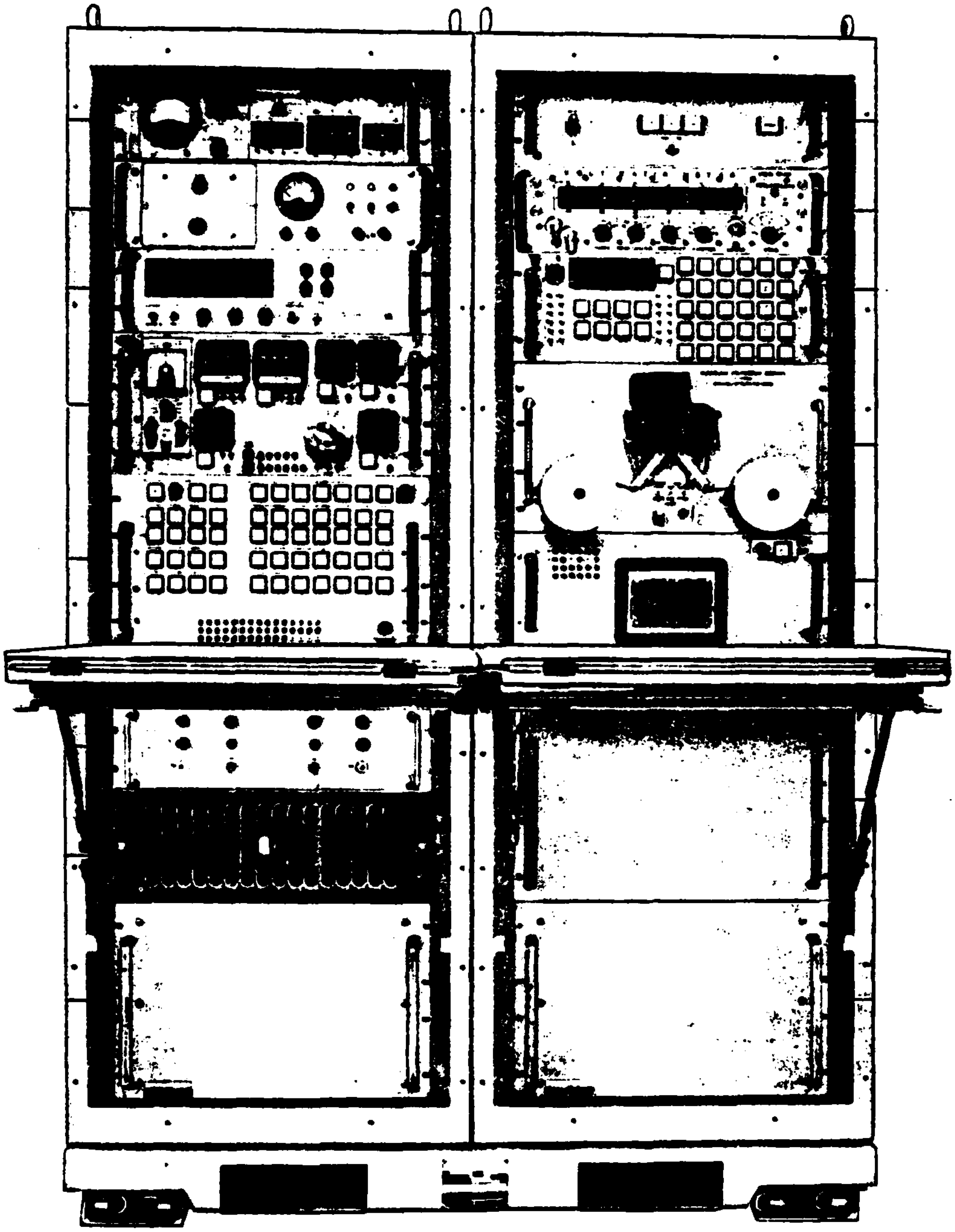

FIG. 3 F/FB-111 CENTRAL AIR DATA COMPUTER (CADC) TEST STATION

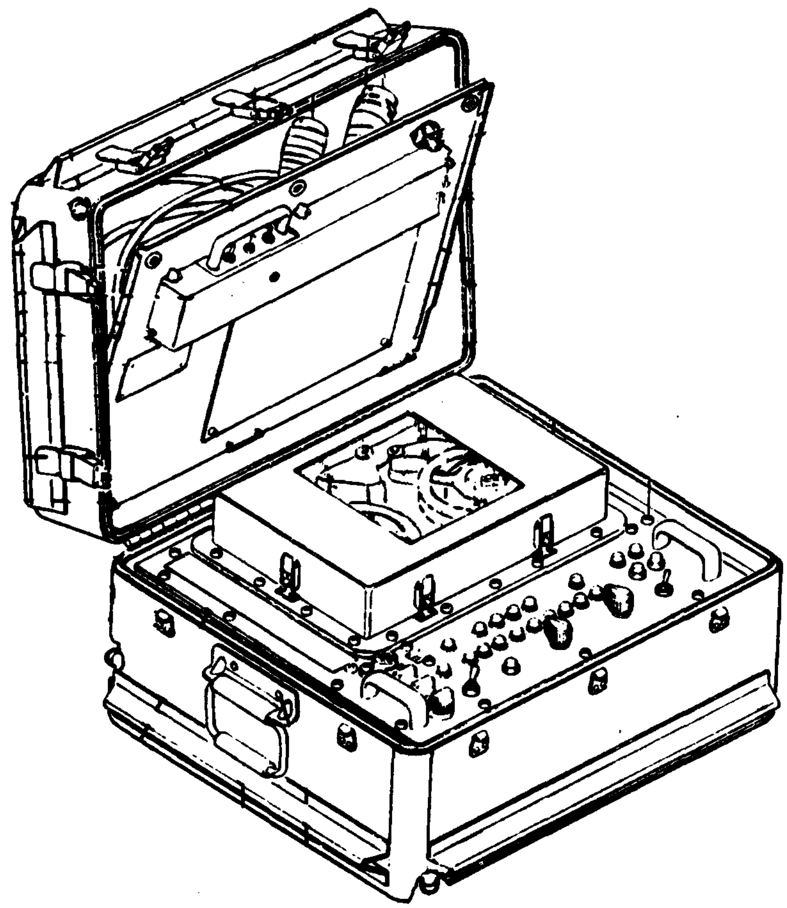

FIG. 4 F/FB-111 TAPE READER

Both of these candidate testers have lower usage rates than other ATE units. This is due to the number of aircraft line replaceable units (LRU's) that are tested on the CADC test station and the use of the tape reader on the flight line, which causes it to experience significant idle and transportation times. Other in-shop ATE units incur significantly higher utilization rates due to larger programmed LRU workloads and may operate 24 hours a day for several days during a peak operational period.

To further provide a manageable data collection task, data was collected for the application of these testers to the FB-111 aircraft only. This encompassed data collection from the only two operational FB-111 bases, Pease and Plattsburg AFB's.

Once a candidate system had been selected, the subsystems and the component TRU's were identified. This was most easily accomplished by use of the WUC breakdown structure listed in T.O. 51-1-06-1 (68). This breakdown structure identifies the various components of a system and systematically assigns a unique code to each component. The code consists of five alphabetic and numeric characters and identifies end items, systems, subsystems, and components upon which maintenance actions are performed (68:II-002). Figure 5 shows the assignment of WUC's to the various levels of breakdown structure for the CADC. <u>T.O. 51-1-06-1 identifies an end item by the use of the @ symbol</u>

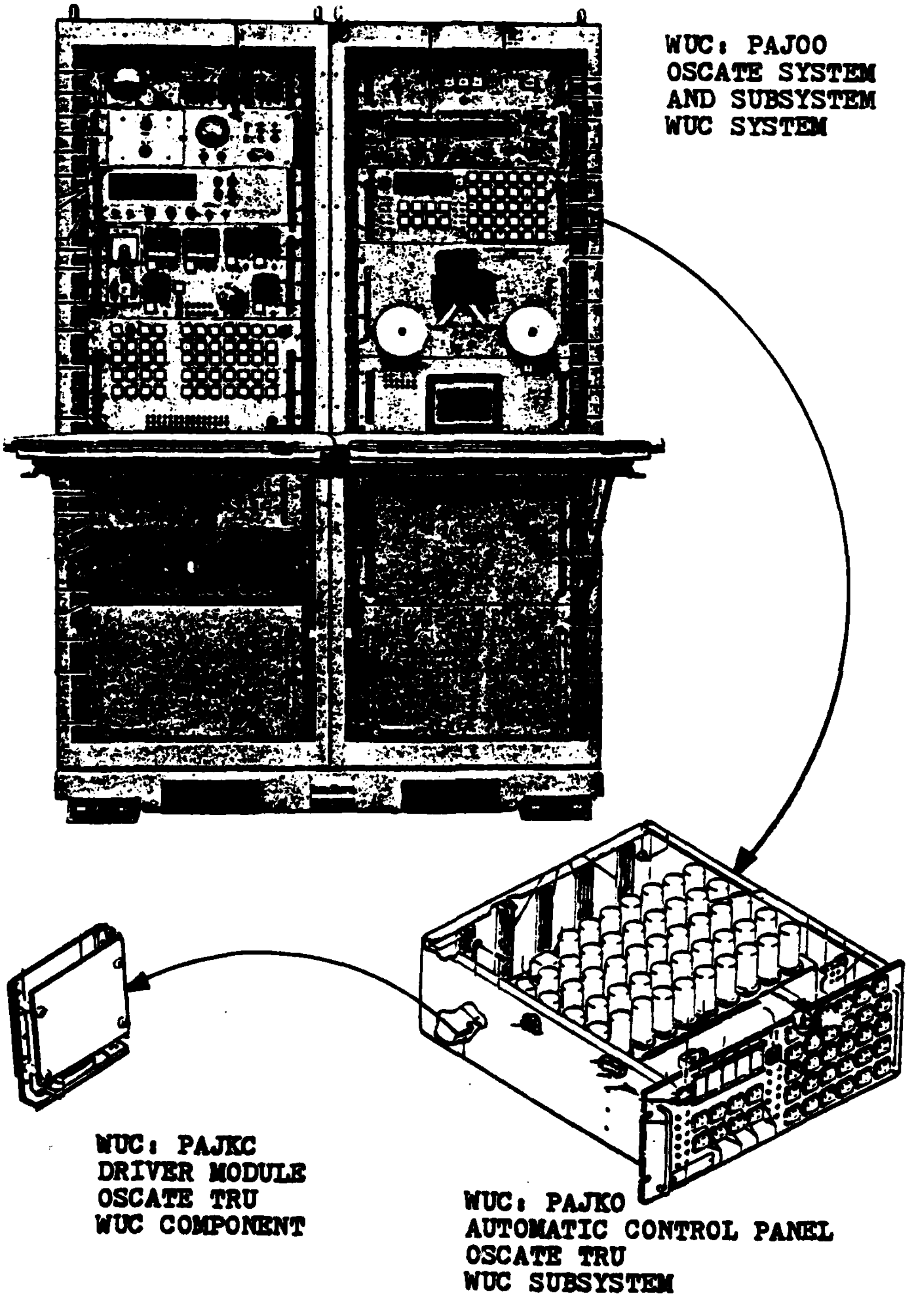

FIG. 5 VARIOUS LEVELS OF WUC ASSIGNMENT F/FB-111 CENTRAL AIR DATA COMPUTER (CADC) TEST STATION

placed next to a listed WUC. The WUC system is usually identified by the assignment of 00 to the rightmost two positions of the WUC (e.g., the tape reader system WUC is PAL00). The WUC subsystem is usually identified by the assignment of 0 to the rightmost position of the WUC. The WUC components are then identified by assignment of various characters other than 0 to all positions including the two rightmost positions. The leftmost three characters assigned to a WUC system are repeated in the same positions in all of the associated subsystem and component WUC's. The WUC terms of system and subsystem do not necessarily coincide with the OSCATE model use of these terms. For this validation task, the OSCATE system and subsystem were both identified to the WUC system. The OSCATE TRU's were identified by the subsystem and component WUC's. The application of these terms is also shown in Figure 5. The relatively small number of WUC's assigned to the candidate systems allowed the use of WUC components as OSCATE TRU's. However, model application to a large ATE system composed of a number of testers, such as the F-15 AIS, would involve approximately five hundred component level WUC's. For this application, the OSCATE TRU level may be assigned to the WUC subsystems in order to provide a manageable data collection task. This may also be necessary by the maintenance concept used with the particular ATE. The lowest level within the system to which a failure may be identifiable by the user may be the WUC subsystem level. This example also identifies a specific case where knowledge of ATE and OSCATE is necessary to insure the application of the model accounts for the peculiarities of the particular situation. Throughout this thesis the terms system and subsystem will be used in relation to the OSCATE model usage unless otherwise identified.

Data Sources and Systems Search

After the selection of candidate systems was made, the data element search procedure was applied to each individual variable. Appendix A details the results of the data search effort and includes a definition of the variable. Since many variables required data collection from a specific data system report, Appendix B was formulated which alphabetically lists the data reports referenced in Appendix A and outlines the search procedure required to locate specific variable information in each data report. The ordering and sequencing of data varies from data report to report. For example, the D056B5505 report lists data by WUC while the D032.505L report lists data by manager designator code and the national stock number (NSN). The method of identifying the needed codes for data search of an individual data report is also contained in Appendix B.

The data report numbers consist of varying length alphanumeric identifiers appended behind the four alphanumeric character data system designator. In the above referenced report, D056B5505, the first four alphanumeric characters, D056 comprise the data system designator (DSD) for the data system that processed and produced the report. The DSD begins with an alphabetic character code that indicates the functional area the DSD pertains to. The identification of the codes is given in AFP300-16 (42) or SA-ALC/KAFBR 300-2 (69). The four digits, 5505, of the above report uniquely identify this specific report. Data report numbers are identified in the directives specified in Appendix B for the report.

Many data reports are distributed outside the originating activity or are generated for a requirement levied by another organization. For recurring reports or reports required on demand by other than the originating activity, a report control symbol (RCS) is assigned to each specific report. For example the D056B5505 report is assigned the RCS of LOG-MMO(AR)7169. Air Force Logistics Command (AFLC) assigned RCS's are listed in AFLCP178-5 (62). This pamphlet details the composition and information coded into the RCS. This pamphlet also lists other information pertinent to the management and control of the RCS. The more important of this data, for a data search, are the basic directives governing the report, report frequency, report recipients, the AFLC office of primary responsibility (OPR), and the associated DSD. This pamphlet only lists the DSD and not the data report number. The report number can be found in the basic directives by identifying the title listed for the RCS with a specific data report in the basic directive (usually an AF or AFLC manual or regulation). Reports generated by Headquarters Air Force are listed similarly as in AFP178-5 (31).

The (DSD) P040E data system lists all AFLC managed data systems by the assigned DSD. The data report contains, among other information, the data system manager and the directives governing the DSD. Each Major Command (MAJCOM) maintains a P040E data system for all the MAJCOM managed data systems.

The (DSD) P005C data system contains a number of data reports that associate various information for RCS rereports generated by AFLC. The P005C-006-MS-ME2 report lists the DSD and the associated RCS reports produced by the DSD.

The various listings mentioned above provide useful sources in determining what data is available and how to access this data. These also identify the directives for a particular report. This is needed in order to obtain an explanation of the data contained in a specific report and how that data is obtained. In this validation process, the search procedure for data elements was applied by requesting applicable information in the various functional areas at the San Antonio Air Logistics Center (SA-ALC) for specific data. Usually, the requested data was available in data reports available in that functional area. For this reason, the data sources listed in Appendix B may not be the only possible source for the data. The P040E data report and AFLCP178-5 (31) were used to identify the applicable directives in order to verify that the data collected represented the desired data.

Government Furnished Variables

The government furnished variables are those that would normally be supplied by the government to the contractor when the model is used during an acquisition process. These variables represent a variety of usage and cost factors that apply at the system level of model input. Table 1 lists these system level variables. As stated previously, Appendix A defines these variables and their data sources, and Appendix B identifies applicable data report search procedures. Peculiarities noted in the data collection of specific variables is discussed below.

Initial Management Cost (IMC)

The latest edition of the usual source for this variable, AFLCR173-10 (30), does not list any information for this variable because previously published cost data was outdated. An Oklahoma City Air Logistics Center, OC-ALC/MMML study is presently underway to collect this

TABLE 1

GOVERNMENT FURNISHED VARIABLES
(System Level)

CARF	POH
IMC	PSC
M	PSO
MRF	RMC
MRO	SA
NSYS	SR
OS	TARGAVAL
OSTCON	TD
OSTOS	TOH
PIUP	TR
PMB	TRB
PMD	TRD
	UEBASE

information. Data already collected for Air Force managed items was used. Future editions of AFLCR173-10 (30) will contain these costs as they become available (D).

Order and Shipping Times (OSTCON and OSTOS)

The usual source for these variables is AFLCR173-10, chapter 5, paragraphs 5-5 and 5-8 (30). This data is stated to be used for rough approximations only. A more accurate method of computing approximate values for these variables is given in Appendix A. Application of this computational method to the candidate systems for CONUS shipments revealed the AFLCR173-10 (30) data was unrepresentative of actual costs.

Recurring Management Cost (RMC)

The usual source for this variable is AFLCR173-10, chapter 4, section B, paragraph 4-2 (30). The present edition of this regulation does not list any data for this variable. The previously published data was found to be outdated and unrepresentative of actual costs. Appendix A lists the data source discovered for this variable.

Base Supply Inventory Management Cost (SA)

The cost figure referenced in the developmental thesis and the LSC model is for the automatic data processing cost for a line item of supply. A more accurate cost figure for the actual line item management cost was found in a report by the Air Force Logistics Management Center.

Base Spares Target Availability (TARGAVAL)

An actual base level spares availability value was used for this variable. The value represents a base average for all maintenance activities. The value was used due to the lack of data for ATE only.

Unit Equivalent ATE (UEBASE)

The specification of this variable at the system level reveals an implicit assumption that all of the M operating bases will operate the same number of units. This is not always the case as was evidenced by the fact that F-111 using bases operated three or four CADC test station units while the FB-111 bases only operated one at each. This can usually be compensated for in the model by inputing an average value for this variable that would represent the correct quantity of units operated at the M bases.

Subsystem Variables

The subsystem level variables represent various cost and maintenance manhour standards applicable to the subsystem. These variables are normally supplied by the contractor when the model is applied during an acquisition. In the case of only one system contained in the ATE under evaluation, these variables effectively become system level variables. Table 2 lists these subsystem level variables. As stated previously, Appendix A defines these variables and their data sources, and Appendix B identifies applicable data report search procedures. Any peculiarities noted in the data collection of these variables are discussed below.

TABLE 2

SUBSYSTEM LEVEL VARIABLES*

BCA	DLR	JJ	SYSNOUN
BLR	DMR	N	TCB
CASYS	DPA	SCI	TCD
CIVLR	DRCTC	SCMH	TE
DAA	DRCTO	SMH	XSYS
DCA	H	SMI	

*These variables are normally supplied by the contractor in model application to an acquisition.

Common Base Shop Equipment (BCA)

In the collection of the data for this variable, the total cost of additional common shop support equipment, it was assumed none of the required support equipment was already available in the shops. In an acquisition application, the available shop support equipment is easily identified by the base shops at which the new system will be operated.

Common Depot Support Equipment (DCA)

The same assumption made for the BCA variable was made for this variable as it would apply to a depot level shop. In an acquisition application, the data for this variable should be readily available from the depot shop.

Peculiar Training Equipment (TE)

The nature of the troubleshooting and testing during a fault isolation largely negates the need for peculiar training equipment. No peculiar training equipment was identified in this data collection effort.

TRU Variables

These variables represent a wide variety of information used to compute costs associated with the individual TRU's. In an acquisition application, the variables are normally supplied by the contractor. Table 3 lists these TRU variables. Appendix A defines these variables and

TABLE 3

TEST REPLACEABLE UNIT (TRU) AND SUPPORT

EQUIPMENT LEVEL VARIABLES

CATRU	IMH
CI	K
CII	MTBF
CIILR	PAMH
CILR	PP
CIV	QPA
DBCMH	RIP
DCOND	RMH
DMC	TRUCI
DMH	TRUCMH
FICR	TRUNOUN
FIICR	UC
FIVCR	W
	XTRU
SUPPORT EQUIPMENT VARIABLES*	
CAD	DUR
COD	XSE
DOWN	

*These variables are input for each of the K (TRU variable) pieces of support equipment specified for a particular TRU.

their data sources, and Appendix B identifies applicable data report search procedures. Any peculiarities noted in the data collection of these variables is discussed below.

TRU's Requiring Calibration (CATRU)

The variable is not contained in the model equations but is used in the computer program to determine whether or not calibration costs should be computed for a particular TRU.

Calibration Factors (CI, CII, CIV)

The determination of the need for calibration of an in-service item by a particular type of PME laboratory is usually not readily available. Most ATE is calibrated at Type II laboratories located at the individual operating bases unless the "CAL TO NO" column of the entry for a particular item in T.O. 33K-1-100 (58) lists "AGMC". This means calibration must be performed by the Aerospace Guidance and Metrology Center (AGMC), located at Newark AFS, which is the only Type I laboratory in the USAF. In some cases T.O. 33K-1-100 (58) lists "NPCR" in the "CAL TO NO" column which means no periodic calibration is required. However, in all cases, any calibration requirements specified in equipment TO's takes precedence over the 33K-1-100 (58) requirements. These TO requirements should not conflict with one another. The base PME laboratory, a Type IIB laboratory, may determine that the calibration of particular items must be performed at depot level, Type IIA, laberatory. The calibration concept applied to the ATE parent weapon system may dictate the use of a Type IV laboratory which is established to support the weapon system and does not perform other base PME workload. The F-15 presently employs a calibration concept that specifies the use of a Type IV PME laboratory. This information is not reflected in T.O. 33K-1-100 (58) and must be obtained through research of the calibration concept for the weapon system. It is available at the particular weapon system System Management office. For an acquisition application, the calibration concept is usually readily available in acquisition and planning documents.

Average Bench Check Manhours (DBCMH)

The data for this variable, the average depot bench check manhours is not normally available. Job orders with a large number of manhours for repair of one unit have the repair actions within a performing work center separated into major actions and required manhours for each. For most depot repaired items, a total manhours per unit repaired and a relatively standard manhour charge for unpacking is all the manhour data available for depot repair. The manhour charges are listed in the G004C-G3A-W1-MGG data report by job order number. The job order numbers applicable to a TRU are identified in the G019CJE11 or CJ016 data reports. For this data collection effort, the value of this variable was assumed to be twenty-five percent of the negotiated repair manhours listed in the G019CJE11 or CJ016 data reports. The depot repair manhours, DMH, value was reduced by twenty-five percent to compensate for the manhours accounted for in this variable.

Average Depot Repair Manhours (DMH)

The value for this variable was taken as seventy-five percent of the negotiated manhours listed in the

G019CJE11 or CJ016 data report. This was done to compensate for the manhours accounted for in the DBCMH variable.

In-Place and Removed Manhours (IMH, RMH)

The data for these variables was obtained from the Base Level Inquiry System (BLIS) extracted maintenance actions covering a six month time period. Due to a lack of, or a small number of, maintenance actions reported against some WUC's, the average IMH and RMH values for all WUC's was assigned to the WUC's with insufficient data. The six month data reviewed indicated that data covering a longer time period should be reviewed in order to include a number of maintenance actions for all WUC's.

Mean Time Between Failures (MTBF)

The D056B5006 data report computes an MTBF for each WUC with maintenance actions reported in the six month period covered by the report. This MTBF is computed using failures defined as maintenance actions with Type 1 how malfunction codes (defined in AFLCR66-15, page 5-2.1 (60)) and an action taken code of F, K, L, or Z (defined in T.O. 51-1-06-1 (68), pp. V-001 to V-003). Equipment usage is computed using 30 days per month multiplied by the reporting inventory of the WUC item. This definition of a failure includes only inherent failures and does not include induced failures, where only minor parts are replaced or other minor repair is required. The induced failures are the Type II maintenance actions defined in AFLCR66-15, page 5-2.1 (60). For the computation of MTBF in this data collection effort, the total number of Type I and II maintenance actions reported in the D056B5505 data report was used. This is consistent with MTBF computations employed in other LSC model applications (9:54).

The computation of MTBF requires the division of operating hours by the number of failures. The number of operating hours was computed using the operating hours reported for the scheduled maintenance interval (SMI) variable.

The D056B5505 data report used above contained one year of maintenance actions for all the reporting inventory of either candidate system. Numerous WUC's had no actions reported for this period. For these items it was assumed one failure would occur in a two year time period. The resulting computed MTBF was then assigned to these WUC's. Many WUC's had only one Type I or II maintenance action reported for the one year time period. Due to these facts, the computed MTBF values were very high and indicated very few if any failures would occur over the program inventory usage period (PIUP) for the ATE. This did not seem realistic and was thought to have been caused by the large number of maintenance actions reported against the WUC system, PAL00 or PAJ00. The second part of the D056B5505 report lists the part numbers and NSN of the items worked on or replaced within a WUC. This revealed that a number of lower level items with WUC's assigned were worked on and reported against the WUC system, PAL00 or PAJ00. The reports for the WUC systems were screened for actions applicable to a lower level WUC and any actions identified were included in the computation of MTBF for the lower level WUC.

TRU Installed Weight (W)

This variable is defined as the installed weight of the TRU. The end item equipment T.O. gives this data for the end item. However, this data was not available for the subsystems or TRU's. The only data available for the subsystems and TRU's was shipping weight and this was used. The OSCATE model includes a multiplication factor of 1.35 for W to compensate for the increase of shipping weight over installed weight. The use of shipping weight in lieu of installed weight therefore induced some error in model computations. This error was considered to be small in relation to the TLSC.

SE Variables

These variables represent utilization and cost factors for each of the K pieces of support equipment specified for use on a TRU. Table 3 includes these variables. Data for these five SE variables was not available except for the cost per unit (CAD) variable. The lack of data was thought to be attributable to the secondary nature of the support provided by SE to the ATE. For example, at the depot the cost to operate and maintain a piece of SE (CAD) is not collected. In a particular Technology Repair Center (TRC), only the aggregate number of manhours spent to repair and maintain all the assigned SE within the work center is available through charges against a cost class IV job order established for this purpose (20). The lack of data for the SE variables did not present any problems in this data collection effort since none of the candidate systems TRU's required any support equipment data.

Equation Costs

Research of numerous data systems and reports revealed data on costs represented by the individual equations or collections of equations was not available. The base level Maintenance Cost System (MCS) was found to track O&S cost for all support equipment used for a particular Mission, Design, or Series (MDS) weapon system. This cost is an aggregate cost and is not decomposed into the costs incurred by the major types of SE, such as tools or ATE, or the individual SE equipment. Operating costs are collected for Responsibility Centers (RC) which represent the various base or depot shops. This cost includes all costs incurred by an RC and does not track costs applicable to an individual piece of equipment used in the RC.

The need to identify O&S costs has been acknowledged by DOD in the issuance of Management by Objective (MBO) 9-2 entitled "Visibility and Management of Support Costs" (VAMOSC). This MBO involves a number of initiatives designed to improve the visibility and management of weapon system operating and support costs. This includes the assimilation and reporting of annual support costs by weapon system (1:2). The data system under development, as presently configured, does not track ATE O&S costs (17). The difficulties and problems encountered in this data collection effort indicate the collection of O&S costs at the component (TRU) level would be very difficult using presently collected data. This data is collected for purposes other than the determination of O&S costs. In the maintenance area, the problem noted of the large number of maintenance actions and manhours charged against the WUC system or subsystem level (i.e., PALOO or PALCO) when the charge may have been more directly attributable to the TRU level (i.e., PALCB) obscures the costs actually incurred by the TRU. Costs are further obscured by the fact that in certain cases two different WUC's are assigned to a particular item. When an item, either a system, subsystem or TRU, requires periodic calibration, a PME WUC is assigned to the item. The PME WUC's are listed in T.O. 33K-1-100 (58) and are assigned by item part, model or type number. There is no direct link between the maintenance and PME WUC's assigned to an item. This assignment of two unique WUC's and the lack of a direct link between the WUC's obscures the total maintenance cost incurred by an item. Usage of an item, either at the subsystem or TRU level, on different ATE systems further compounds the determination of O&S costs. This is particularly evident in the determination of the portion of the depot maintenance cost and inventory management cost attributable to item usage on a particular ATE system.

A Cost Analysis presently under evaluation proposes the replacement of the F/FB-111 AIS with the F-16 AIS. The cost data used for this analysis was obtained from supply and maintenance data systems at the six operational bases. The costs were collected for supply and maintenance actions for the six month period between 1 July and 31 December 1978 (19). Due to the method of determination, the costs used in this report could not be used for determining model prediction accuracy. The costs used in the report were determined from essentially the same data sources used for OSCATE data collection and only reflect components of the TRU spares and on-equipment equations.

The lack of actual O&S costs in existing data sources is evidenced by a previous LSC model application which used the results of a special cost study for evaluation of model prediction accuracy (9:72). The lack of equation cost data precluded the evaluation of model prediction accuracy. A subjective indication of accuracy may be obtained from the discussions of model limitations and data collection problems encountered.

Exercising the Model

The OSCATE model was exercised through a computer program on the AFLC CREATE system. Appendix C details the steps employed in exercising the OSCATE computer model. The data set resulting from this data collection effort is contained in Appendix D for the tape reader and Appendix E for the CADC test station.

Two minor errors discovered in the OSCATE program as listed in the developmental thesis were corrected (12: 133-145). These errors were format type errors which did not affect program computations or results. Appendix F lists the corrected OSCATE program.

As with any computer program, care must be taken in the input of data to insure the data is matched with the corresponding variable. Figure 6 shows an example data file structure. This figure shows how the number of data blocks input for the various subsystem, TRU, and SE levels is dependent on the values of the variables NSYS, N, and K. The system level variables are input only once and at the beginning of a data file.

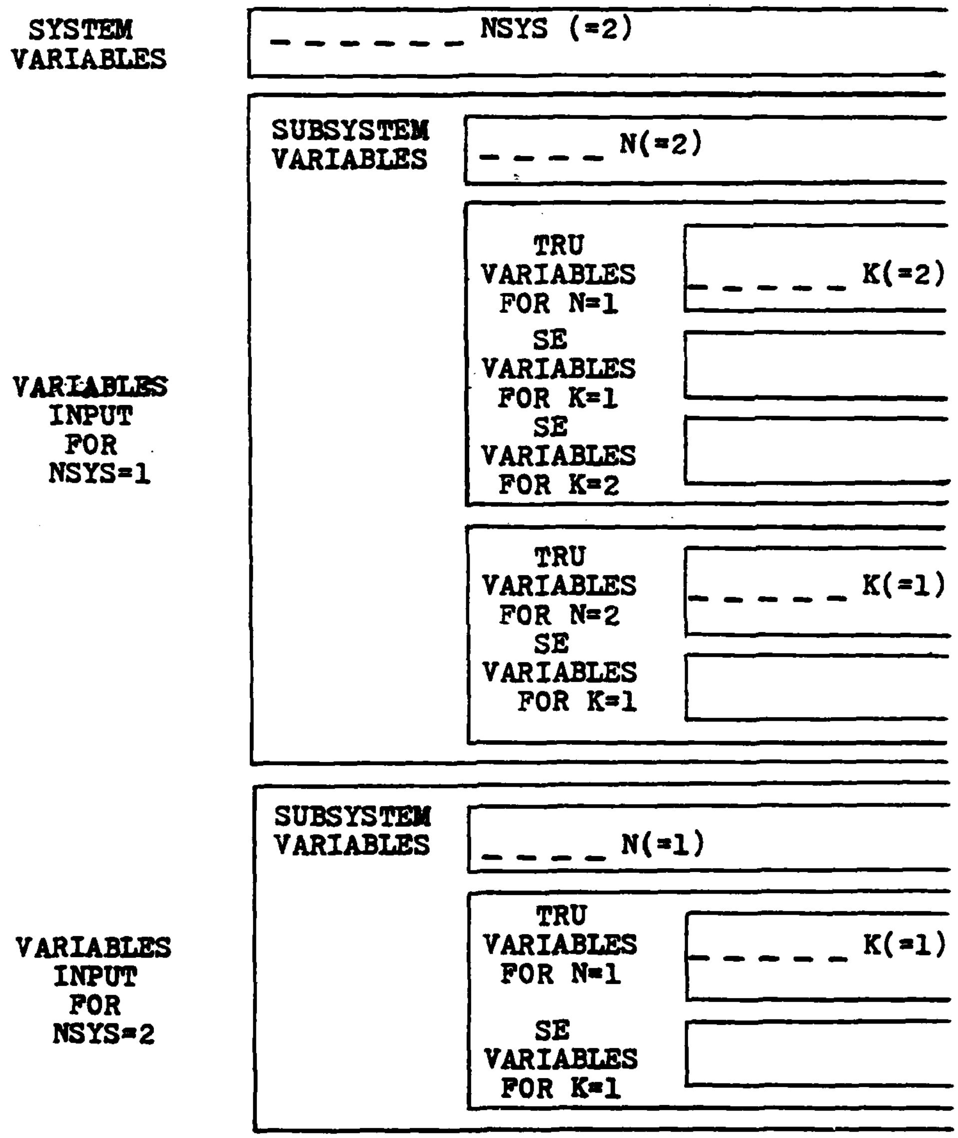

FIG. 6 EXAMPLE DATA FILE STRUCTURE

During the exercising of the model for this validation effort, it was found that coding of the data file line numbers greatly eased checking of input values and changing variable values. The coding used allowed easy identification of a particular line of data input for all TRU's. For example, the value for MTBF for each TRU is the third value on all line numbers whose last two digits are 02. The four input data lines which comprise the data block for a particular TRU all have the first two digits in common. In an acquisition application, changes to the data set may have to be accomplished in the evaluation of various alternatives.

When the model program is exercised, the following warning message is output:

Source line 5790

(W) 1470 EQUALITY OR NON-EQUALITY COMPARISON MAY NOT BE MEANINGFUL IN LOGICAL IF EXPRESSIONS.

This warning message indicates that IF statement comparisons in the program contain floating point numbers and truncation occurs in the comparison. This has no effect on the results of this program.

Appendix G contains model output results for the tape reader and Appendix H contains model output results for the CADC test station.

The total LSC of $1.29 million for the tape reader and $944,187.00 for the CADC test station is the computed total O&S cost incurred by the total inventory (M multiplied by UEBASE) over the program inventory usage period (PIUP). The option 4 output for the tape reader for example states the 18 TRU's, which is all the TRU's evaluated in this system, comprise 43 percent of the total LSC cost. These costs represent those components of the individual equations identified by a summation over the N TRU's. The remaining 57 percent of the total LSC is contributed by the individual equation components that are not computed by a summation over the N TRU's (i.e., equation 2 component TOH/SMI(SMH)(BLR)). The option 7 output lists the mean demands (DMDMEAN), expected backorders (XBO), availability (AV), operating base stock level (STK), depot pipeline spares (DPIPE), and the total condemnations (TOTCOND) all given in TRU units. The system availability listed is the product of all the listed TRU availabilities. The option 8 output lists the number of off-equipment and the total maintenance actions generated for the peak operating hours and the total operating hours for each TRU.

Evaluation of Results

Due to the lack of equation cost data, evaluation of prediction accuracy could not be accomplished. An evaluation of model results was accomplished on the variables for which the data collected was not directly available and an assumption or averaging of data was used. The variables TOH, POH, TARGAVAL and MTBF were thought to have the most

TABLE 4

EFFECT OF TOH ON TLSC

Operating Hours per Tape Reader	TOH		TLSC ($ in Millions)	Percent Increase in TLSC
		Tape Reader		
7625	76250	(Baseline)	1.29	----
10000	100000		1.32	2.33
15000	150000		1.39	7.75
		CADC		
15620	31240	(Baseline)	944187	---
20000	40000		953097	0.94
30000	60000		973439	3.10

effect on the computed Total Logistic Support Cost (TLSC) of the variables with data not directly available. The baseline value from the input data set was varied and results are detailed below.

The total operating hours (TOH) variable value was increased for each candidate system and Table 4 details the resulting effect on TLSC. The value of TOH was increased because the baseline values were low relative to the value other ATE might incur. Doubling of the baseline TOH value caused less than an eight percent increase in TLSC. The computation of TOH using actual operating hours between scheduled inspections did not overly influence the computed TLSC.

TABLE 5

EFFECT OF POH ON TLSC

Tape Reader	
POH	TLSC ($ in millions)
1800 (Baseline)	1.29
2400	1.29
3600	1.29
CADC	
POH	TLSC ($)
365 (Baseline)	944187
487	944187
730	944187

The baseline value for peak operating hours, POH, was increased for each candidate system and Table 5 details the effect on TLSC. The value of POH was increased because the baseline values were low relative to what other ATE might experience. The increase of POH to a utilization of 24 hours per day for the CADC (POH=730) had no effect on TLSC. This indicates the data used for the value of POH had minimal effect on the computed TLSC. The tape reader value of POH was not increased to a 24 hour utilization since this would be unrealistic for a portable unit such as this.

The base level spares availability, TARGAVAL, was varied from .7 to .995 and no effect was noted except for a one percent increase in TLSC for the tape reader and CADC

TABLE 6

EFFECT OF TRU MTBF ON STOCK LEVELS
(for TARGAVAL=.78)

Tape Reader
(for TARGAVAL=.78)

TRU:PALCQ MTBF	STK	DPIPE	TOTCOND
7745 (Baseline)	0	1	1
7000	0	1	1
5000	0	1	1
3000	0	1	1
1000	0	2	1
500	0	4	2

CADC
(for TARGAVAL=.78)

TRU:PAJHA MTBF	STK	DPIPE	TOTCOND
5680 (Baseline)	0	1	0
5000	0	1	0
3000	0	1	0
1000	0	1	0
500	0	1	0

at the .995 value. This indicates that the baseline value did not overly affect the computed TLSC.

The computed MTBF values were very large in relation to TOH for most of the TRU's for either candidate. For this reason, the MTBF for one TRU for each candidate was decreased to various values. Each TRU chosen had one of the lowest values of MTBF. Since only one TRU MTBF was varied, the computed stock levels were used for comparative purposes. Table 6 details the results obtained. The

TABLE 7

EFFECT OF TRU MTBF ON STOCK LEVELS
(for TARGAVAL=.99)

Tape Reader
(for TARGAVAL=.99)

TRU:PALCQ MTBF	STK	DPIPE	TOTCOND
7000	1	1	1
5000	1	1	1
3000	1	1	1
1000	2	2	1
500	2	4	2

CADC
(for TARGAVAL=.99)

TRU:PAJHA MTBF	STK	DPIPE	TOTCOND
5000	0	1	0
3000	0	1	0
2000	1	1	0
1000	1	1	0
500	1	1	0

resulting insensitivity of the stock levels was thought to have been contributed to by the TARGAVAL baseline value. The MTBF's were again varied using an increased TARGAVAL value of .99. Table 7 details the results obtained. These results indicated the computed stock levels are relatively constant for values of MTBF between 7000 and 2000. Below the 2000 hours value computed stock levels increased. This indicates that the computed TLSC was not overly influenced by the computed MTBF values. An accurate computation of

MTBF is still necessary due to possible effect caused by the combination of several variables in the data set. The difference in effect on stock levels by varying MTBF is evident by the lesser effect noted for the CADC versus the tape reader.

Summary

The results obtained from the validation process have been presented in this chapter. Evaluation of model requirements revealed the need for user knowledge of not only the model but also ATE. The many considerations in candidate selection have been discussed. The foremost consideration is the availability of data. The data sources and systems search described the organization of the large body of data sources in order to simplify the search procedure. Peculiarities discovered during data collection for each variable have been discussed along with any perceived impact. The lack of equation costs precluded the evaluation of prediction accuracy. The exercising of the model has been discussed to assist in model application. The model results using the collected data sets have been evaluated. The variables TOH, POH, TARGAVAL, and MTBF were the variables not directly available in the data collection effort and were thought to have an important effect on TLSC. Evaluation of these variables revealed that varying individual variables had only a minimal effect on TLSC. However, varying more than one variable has a greater effect on TLSC. Significantly lower values of MTBF effected the TLSC. The final chapter of this thesis will discuss the results described in this chapter and draw conclusions from them. In addition, recommendations for further research will be made.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

This research was accomplished with the primary objective of validating the operating and support cost model for avionics automatic test equipment (OSCATE). An ancillary objective was to define the data base required to exercise the model. These objectives necessitated answering five research questions:

1) What data are necessary to exercise the OSCATE model?

2) What additional data are necessary to accomplish the cost comparisons necessary for validation?

3) What are the sources of the needed data?

4) How must the needed data be extracted or obtained from the available source?

5) How accurately does the OSCATE model estimate actual O&S cost of ATE?

As indicated in the analysis of Chapter IV, sources for data of the actual cost of ATE (question 3) could not be determined due simply to their nonavailability. The lack of actual costs for comparison with computed costs precluded validation in the conventional sense of determining model accuracy. However, several important lessons were learned in the attempt and are discussed in this chapter. This chapter is divided into three sections: (1) Data Base for Model Use; (2) Model Prediction Accuracy; and (3) Recommendations for Further Research.

Data Base for Model Use

This research has achieved the first stated research objective of identifying the data base and details on the data collection methods. These results were obtained through answers to the research question on the necessary data, data sources, and extraction methods. The data collection and research has revealed the data needed to exercise the OSCATE model is almost entirely available and possible sources for the data not presently available have also been identified. The definition of the needed data base enhances model utility. The lack of a linkage between model data and historical data caused a large part of this validation task to be devoted to identifying and defining this linkage.

The establishment of the data base for model use also provides a method by which parameter values specified by the contractor during acquisition may be compared with the values experienced by in-service ATE. This comparison would provide an indication of how and in what areas the contractor's proposed ATE would be an improvement over existing equipment. Knowledge of the ATE involved would be necessary to perform this comparison and also would be or adjustment. Since the model was developed for use during acquisition, the model was not modified. The specification of these variables will provide an insight into how O&S costs will be incurred and areas for comparison of proposed alternatives. The specification of the data base also suggested the basis upon which a data system might be established for tracking of ATE O&S costs.

Model Prediction Accuracy

As stated previously the determination of model prediction accuracy could not be accomplished. This was due to the lack of the needed cost data for comparison with computed costs. The cost data that is collected and available is aggregate cost data, such as the costs to operate and maintain the base ATE shop. The aggregate cost data coupled with the difficulty of allocating these costs to a particular tester among the many in use in the ATE shop precluded obtaining a reliable estimate of actual costs.

The determination of model accuracy is, of course, a key to gaining user acceptance of the OSCATE model. Previous LSC-type model applications have used cost data obtained through special studies or projects for determining model accuracy. The recent cost analysis of the F/FB-111 ATE utilized costs determined by a special survey team. Costs were computed utilizing reported maintenance and supply (consumption) actions and standard costs such as maintenance manhour costs and unit costs. This method is similar to the OSCATE model method of computing costs except that actual individual action costs are summed versus the model summation of costs based on average manhours and the expected failures. The maintenance and supply costs only represent two of the O&S contributing costs included in the OSCATE model. These examples of the lack of cost data indicates the need for the establishment of data sources for ATE O&S costs.

The accomplishment of the data collection task revealed that from a subjective viewpoint the model is valid. The inclusion of important cost contributors and the accounting type structure of OSCATE provided the basis for concluding OSCATE is valid. Validity must be kept in the context of the model limitations discussed herein and in the developmental thesis. Model limitations generally contribute to the simplicity of the model structure and to minimization of the required data collection effort. Actual acquisition applications may require model modifications to conform to the specific application.

To further establish user confidence, sensitivity analysis should be employed in model applications. Sensitivity analysis, to some extent, is inherent in model application during an acquisition. The evaluation of various design alternatives will require the introduction of different values for various variables. Performing this analysis of design alternatives in a structured manner will demonstrate that the model will react in the manner anticipated. For example, if mean time between failure (MTBF) increases, we would expect computed costs for maintenance to decrease. Model results should reflect this expected reduced cost and thereby give a further indication of model validity.

Recommendations for Further Research

The results and conclusions of this validation task have revealed areas requiring further research and analysis. Recommendations for further study are presented below.

Model Development Recommendations

The results of this validation task have provided reinforcement of the recommendations for the development of a model equation for software costs and the testing of assumptions regarding the availability of ATE. As recommended in the developmental thesis, these areas require further study in order to provide a model that is more encompassing of O&S cost contributors.

Determining Actual ATE O&S Costs

Further studies are required to determine actual costs incurred. This will allow an evaluation of model prediction accuracy. The evaluation of prediction accuracy will allow for a more accurate LCC evaluation during acquisition and will greatly enhance user confidence. The collection of actual cost data will probably require the collection of cost data not presently collected by a field survey team or task force. A candidate ATE system would have to be chosen that would have historical data for the model variables available.

Application of the OSCATE model in an actual ATE acquisition could provide the needed cost data. The actual costs incurred during an acquisition are usually more visible and available. The use of acquisition data systems should significantly ease the data collection. This type of application could also verify the contribution of the various model components to the total O&S cost and identify any additional cost contributors.

Collection of Variable Data Not Available

The need exists to provide for the collection of the data for the variables for which data was not available. This will probably require changes to present data collection methods such as the addition of maintenance data codes for ATE that would be separable into the manhour groupings for in-place repair, removal for repair, and preparation and access. The collection of this data will not only ease model application but also provide visibility of their contribution to O&S costs.

Establish an ATE O&S Cost Data System

The need for collection of a large amount of data for model computation of ATE O&S costs indicates the need for establishment of a data system for this purpose. The needed data was found to be largely available in present data systems and sources but was very poorly linked together if at all. The sources of the available data have been identified along with any manipulative algorithms necessary to transform the data to the needed form. This provides a starting point for the development of a new data system. This data system should provide a breakdown of the O&S costs into the cost components of the OSCATE model equations. The availability of O&S cost components will ease the identification of problem areas which are incurring excessive or disproportionate costs. An ATE O&S cost data system will also provide a single source for this valuable management information.

Analysis of the Value of Availability

An evaluation of the relative value of various availability levels may be obtained through sensitivity analysis using the OSCATE model. This sensitivity analysis should develop families of curves that would depict the changes in computed costs for various levels of availability. The variation of additional variables such as MTBF and TOH will further reveal the relative value of levels of availability. To permit maximum useability of the results of this analysis, the candidate system used should be representative of a significant quantity of the in-service ATE.

APPENDICES

APPENDIX A

OSCATE EQUATIONS, VARIABLES, AND DATA SOURCES.

OSCATE EQUATIONS

COST OF TRU SPARES (C_1)

$$C_1 = M \sum_{i=1}^{N} STK_i(UC_i)$$

$$+ \sum_{i=1}^{N} \frac{(POH)(QPA_i)(1-RIP_i)(1-DCOND_i)(DRCT)}{MTBF_i} UC_i$$

$$+ \sum_{i=1}^{N} \frac{(TOH)(QPA_i)(1-RIP_i)(DCOND_i)}{MTBF_i} UC_i$$

ON-EQUIPMENT MAINTENANCE (C_2)

$$C_2 = \sum_{i=1}^{N} \frac{(TOH)(QPA_i)}{MTBF_i}$$

$$\left[PAMH_i + (RIP_i)(IMH_i) + (1-RIP_i)(RMH_i)\right] \quad BLR$$

$$+ \frac{TOH}{SMI} (SMH)(BLR)$$

OFF-EQUIPMENT MAINTENANCE (C_3)

$$C_3 = \sum_{i=1}^{N} \frac{(TOH)(QPA_i)(1-RIP_i)}{MTBF_i} \Big\{\Big[(DBCMH_i)(DLR) +$$

$$(1-DCOND_i) \Big((DMH_i)(DLR+DMR) + (DMC_i)(UC_i)\Big)\Big] +$$

$$2 \left[(PSC)(1-OS) + (PSO)(OS)\right] \quad (1.35W_i)\Big\}$$

INVENTORY MANAGEMENT Cost (C_4)

$$C_4 = [IMC+(PIUP)(RMC)] \sum_{i=1}^{N} (PP_i+1) + (PIUP)(M)(SA)(N)$$

COST OF SUPPORT EQUIPMENT (C_5)

$$C_5 = \sum_{i=1}^{N} \frac{(POH)(QPA_i)(1-RIP_i)\ [DBCMH_i + (1-DCOND_i)(DMH_i)]}{MTBF_i} \cdot$$

$$\sum_{j=1}^{K} \frac{[(1+PIUP)(COD_j)(CAD_j)]}{(DUR_j)(DAA)(1-DOWN_j)}$$

$$+ \Big[1+0.1(PIUP)\Big] \Big[\ DCA+DPA+M(BCA)\Big]$$

COST OF PERSONNEL TRAINING (C_6)

$$C_6 = \frac{[1 + (PIUP-1)(TRB)]}{(PIUP)(PMB)} (TCB) \Bigg[\sum_{i=1}^{N} \frac{(TOH)(QPA_i)}{MTBF_i}$$

$$\Big\{ PAMH_i + RIP_i(IMH_i) + (1-RIP_i)(RMH_i) \Big\} + \frac{TOH}{SMI}(SMH) \Bigg]$$

$$+ \frac{1 + (PIUP - 1)(TRD)\quad TCD}{(PIUP)(PMD)} \cdot$$

$$\sum_{i=1}^{N} \frac{(TOH)(QPA_i)(1-RIP_i)\ [DBCMH_i + (1-DCOND_i)DMH_i]}{MTBF_i} + TE$$

COST OF MANAGEMENT AND TECHNICAL DATA (C_7)

$$C_7 = \sum_{i=1}^{N} \frac{(TOH)(QPA_i)}{MTBF_i} [MRO + (1-RIP_i)(SR + TR + MRF)]\ BLR$$

$$+ \frac{TOH}{SMI} [MRO + 0.1(SR + TR)]\ \ BLR + TD(JJ + H)$$

<u>CALIBRATION REQUIREMENTS</u> (C_8)

$$C_8 = \sum_{i=1}^{NSYS} \left\{ \frac{365(PIUP)(SCMH_i)(CIVLR)}{(SCI_i)} + \sum_{j=1}^{N} \frac{365(PIUP)(QPA_{ij})}{(TRUCI_{ij})} \right.$$

$$\left\{ (TRUCMH_{ij}) \left[(CI)(CILR) + (CII)(CIILR) + (CIV)(CIVLR) \right] \right.$$

$$+ (CARF \left[(CI)(CILR)(FICR) + (CII)(CIILR)(FIICR) \right.$$

$$\left. \left. \left. + (CIV)(CIVLR)(FIVCR) \right] \right\} \right\}$$

BCA - Total cost of all <u>additional</u> items of common base shop support equipment per base required for the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 5
UNITS: $/Base
DATA SOURCE(S): -1 T.O., CRL-1, ML-C
METHOD OF DATA COLLECTION: Identify any needed SE in -1 intermediate and organizational T.O.'s for the system, subsystems, and TRU's noting part number (P/N). Convert P/N to a National Stock Number (NSN) using the CRL-1 data report. Obtain the unit price for each NSN in the ML-C data report. Determine which items are not presently in the R14/902-13 data report for the operating bases. Sum the prices of all items not in the R14/902-13 data report.

BLR - Base labor rate, including indirect labor, indirect material and overhead.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 2,7
UNITS: $/Manhour
DATA SOURCE(S): AFLCR 173-10 (30)
METHOD OF DATA COLLECTION: AFLCR 173-10, Chapter 3, paragraph 3-4, p. 3-1 (30). Present edition lists the labor rate as $16.42/manhour.

CAD - Cost per unit of peculiar support equipment for the depot shop.

LEVEL INPUT INTO OSCATE: Support Equipment
USED IN EQUATION(S) #: 5
UNITS: $
DATA SOURCE(S): -1 series T.O.'s, CRL-1, ML-C
METHOD OF DATA COLLECTION: Identify part number (P/N) of peculiar SE in -1 series T.O.'s. Convert P/N to NSN using CRL-1 data report. Find unit price in ML-C data report.

CARF - The fraction of units to be calibrated that require repair.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 8
UNITS: Dimensionless (input as decimal number)
DATA SOURCE(S): BLIS
METHOD OF DATA COLLECTION: For a specified time period, sum the number of units that have an action taken code of F or G (T.O. 51-1-06-1 (68)) for the PMEL WUC (33K-1-100 (58)), or with a maintenance WUC (T.O. 51-1-06-1 (68)) reported with an action taken code of F or G with a when discovered code of V or T (T.O. 51-1-06-1 (68)) divide the above number by the total number of units calibrated in the specified time period.

CASYS - Number of systems to be calibrated.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None, used in computer program
UNITS: Number of systems
DATA SOURCE(S): 33K-1-100 (58), -1 T.O.
METHOD OF DATA COLLECTION: Sum of the individual subsystems listed in T.O. 33K-1-100 (58) requiring calibration or with calibration required per their individual -1 T.O. Used to compute system calibration costs.

CATRU - Number of TRUs requiring calibration.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: None, used in computer program
UNITS: Number of TRU's
DATA SOURCE(S): 33K-1-100 (58), -1 T.O.
METHOD OF DATA COLLECTION: Sum of the number of items contained in an OSCATE TRU that require repair per T.O. 33K-1-100 (58) or the -1 T.O. Used in the computer program to compute TRU calibration costs.

CI - Factor which is 0 if no calibration at Type I lab is required or 1 if calibration at Type I lab is required.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Dimensionless
DATA SOURCE(S): 33K-1-100 (58), 00-20-14 (28)
METHOD OF DATA COLLECTION: The types of PME labs are listed in T.O. 00-20-14 (28). The only Air Force Type I lab is located at the Aerospace Guidance and Metrology Center (AGMC), Newark AFS OH. All items requiring calibration at AGMC are identified in T.O. 33K-1-100 (58).

CII - Factor which is 0 if no calibration at Type II lab is required or 1 if calibration at Type II lab is required.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Dimensionless
DATA SOURCE(S): 00-20-14 (28)
METHOD OF DATA COLLECTION: The use of a Type II lab per T.O. 00-20-14 (28) is identified by the calibration concept utilized by the weapon system supported by the ATE. The Type IIB labs located at the operating bases are normally used unless the Type IIB determines that calibration must be accomplished at a depot level, Type IIA, lab.

CIILR - Labor rate at a Type II lab.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: $/Manhour
DATA SOURCE(S): AFLCR 173-10 (30), T.O. 00-20-14 (28)
METHOD OF DATA COLLECTION: The location of the applicable type lab is determined from T.O. 00-20-14 (28). The labor rate is then determined from AFLCR 173-10 chapter 3 (30).

CILR - Labor rate at a Type I lab.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: $/Manhour
DATA SOURCE(S): AFLCR 173-10 (30), T.O. 00-20-14 (28)
METHOD OF DATA COLLECTION: The location of the applicable Type I lab is determined from T.O. 00-20-14 (28). AGMC is presently the only Type I lab in the Air Force. The labor rate is then determined from AFLCR 173-10, chapter 2 (30).

CIV - Factor which is 0 if no calibration at Type IV lab is required or 1 if calibration at Type IV lab is required.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Dimensionless
DATA SOURCE(S): T.O. 00-20-14 (28)
METHOD OF DATA COLLECTION: The use of a Type IV lab per T.O. 00-20-14 (28) is identified by the calibration concept utilized by the weapon system supported by the ATE. The Type IV labs are established to support the particular weapon system and use portable.

CIVLR - Labor rate at the Type IV PMEL lab.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 8
UNITS: $/Manhour
DATA SOURCE(S): AFLCR 173-10 (30), T.O. 00-20-14 (28)
METHOD OF DATA COLLECTION: The location of the applicable Type IV lab is determined from T.O. 00-20-14 (28). The labor rate is then determined from AFLCR 173-10, chapter 3 (30).

COD - Annual cost to operate and maintain a unit of support equipment at depot level expressed as a fraction of the unit cost (CAD).

LEVEL INPUT INTO OSCATE: Support Equipment
USED IN EQUATION(S) #: 5
UNITS: Dimensionless (Input as a decimal number)
DATA SOURCE(S): Depot shop
METHOD OF DATA COLLECTION: This data is not presently collected. An aggregate value of the cost to maintain all support equipment may be available in the depot shop from changes made against a cost class IV job order established for this purpose. An allocation of the aggregate value may be made and then divided by the unit price (CAD) to obtain the desired dimensionless value.

DAA - Available work time per man at the depot in manhours per month.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 5
UNITS: hours/man/month
DATA SOURCE(S): AFLSC 173-10 (30), AFM 26-3 Vol.I (33)
METHOD OF DATA COLLECTION: This data is listed in AFLCR 173-10, chapter 6 (30) which was obtained from AFM 26-3, Air Force Manpower Standard, volume I, table 2-1 (33).

DBCMH - Average manhours to perform a depot shop bench check, screening, and fault verification on a removed TRU prior to initiating repair action or condemning the item.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 3, 5, 6
UNITS: Manhours
DATA SOURCE(S): G019CJE11 or CJ016
METHOD OF DATA COLLECTION: This data is not normally available. The total manhours spent for depot repair per item are listed in the G019CJE11 or CJ016 data report under the "negotiated hours" column. An estimate of this variable value was 25 percent of the negotiated manhours.

DCA - Total cost of additional items of common depot support equipment required for the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 5
UNITS: $
DATA SOURCE(S): -1 T.O., CRL-1, ML-C
METHOD OF DATA COLLECTION: Identify any needed SE in the -1 T.O.'s for the system, subsystem, and TRU's noting part numbers (P/N). Convert P/N to National Stock Number (NSN) using the CRL-1 data report. Obtain the unit price for each NSN using the ML-C data report. Determine which items are not presently in the R14/902-13 data report for the depot shop. Sum the unit prices of all items not found in the R14/902-13 data report.

DCOND - Fraction of TRUs returned to the depot for repair expected to result in condemnation at depot level.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 1, 3, 5, 6
UNITS: Dimensionless
DATA SOURCE(S): D041.91A
METHOD OF DATA COLLECTION: This data is obtained by dividing the total number of units in the "depot cond" row of the D041.91A data report by the sum of these units plus the total units in the "depot repaired" row.

DLR - Depot labor rate, including other direct costs, overhead and G&A.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 3
UNITS: $/Manhour
DATA SOURCE(S): AFLCR 173-10 (30), AFLC/MAJA
METHOD OF DATA COLLECTION: This data is listed in the AFLCR 173-10, chapter 2 (30). More accurate data is available from Hq. AFLC/MAJA.

DMC - Average cost per failure for a TRU repaired at depot level for stockage and repair of lower level assemblies expressed as a fraction of the TRU unit cost (UC). This is the implicit repair disposition cost for a TRU representing labor, material consumption, and stockage/replacement of lower indenture reparable components within the TRU (e.g., shop replaceable units or modules).

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 3
UNITS: Dimensionless
DATA SOURCE(S): G019CJE11 or CJ016
METHOD OF DATA COLLECTION: The data for this variable is obtained by the formula

$$DMC = \frac{\text{Unit Price} - \text{Repair cost}}{\text{Unit Price}}$$

the repair cost is obtained by multiplying the negotiated hours from the G019CJE11 or CJ016 data report by the DLR variable. The repair cost is then subtracted from the unit price listed in the G019CJE11 or CJ016 data report and this value is divided by the unit price. The D041.F92A data report lists the above data from the G019CJE11 or CJ016 data reports but is usually not as current data as the G019 data.

DMH - Average manhours to perform depot level maintenance on a removed TRU including fault isolation, repair, and verification.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 3, 5, 6
UNITS: Manhours
DATA SOURCE(S): G019CJE11 or CJ016, D041.F92A
METHOD OF DATA COLLECTION: This variable is defined in the G019CJE11 or CJ016 data report under the "negotiated hours" column. If a percentage of this value is allocated to DBCMH then this value should be decreased accordingly. This information is also listed in the D041.F92A data report but is not updated only after the G019 is updated and therefore may not be accurate.

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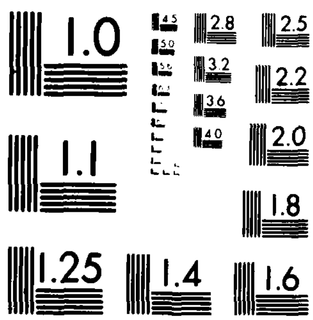

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DMR - Depot consumable material consumption rate. Includes minor items of supply (nuts, washers, rags, cleaning fluid, etc.) which are consumed during repair of items.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 3
UNITS: $/Manhour
DATA SOURCE: HAF-ACD(M)7107, DD-COMP(AR)1092
METHOD OF DATA COLLECTION: This data is obtained by dividing the General Ledger Accounts Code (GLAC) 31121 value for a particular depot by Direct Product Standard Hours (DPSH). The DPSH are specified in the RCS: DD-COMP(AR) 1092 and the GLAC are specified in data report HAF-ACF(M) 7107.

DOWN - Fraction of downtime for a unit of support equipment for maintenance and calibration requirements.

LEVEL INPUT INTO OSCATE: Support Equipment
USED IN EQUATION(S) #: 5
UNITS: Dimensionless
DATA SOURCE(S): Base or depot shops
METHOD OF DATA COLLECTION: This data is not normally collected due to the fact the support equipment is secondary and only presents a problem when needed to support the ATE. The depot or base shop may provide rough estimates of this variable. BLIS data on the PME WUC's for these items may provide some data on the length of time over which the calibration is accomplished.

DPA - Total cost of peculiar depot shop support equipment per base required for the system which is not directly related to repair of specific TRUs or when the quantity required is independent of the anticipated workload (such as overhead cranes and shop fixtures).

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 5
UNITS: $
DATA SOURCE(S): -1 Equipment T.O., R14/902-13
METHOD OF DATA COLLECTION: This shop support equipment is identified in the -1 equipment T.O. The CRL-1 data report may be used to convert the part number to an NSN. The unit price can then be obtained from the ML-C data report and the summation of all unit prices then results in the value of this variable. The R14/902-13 data report also lists the unit price of the shop assigned SE.

DRCT - Weighted average Depot Repair Cycle Time in months. This the time elapsed for a NRTS item from removal of the failed item until it is returned to depot serviceable stock. This includes the time required for base-to-depot transportation and handling and the shop flow time within the specialized repair activity required to repair the item. This variable is computed as follows:

$$DRCT = (DRCTC)(1-OS) + (DRCTO)(OS)$$

LEVEL INPUT INTO OSCATE: Not input, program computed
USED IN EQUATION(S) #: 1
UNITS: Not applicable
DATA SOURCE(S): Variables DRCTC, DRCTO, OS
METHOD OF DATA COLLECTION: This data is not collected directly but is computed in the computer program using the variables DRCTC, DRCTO, and OS as shown above.

DRCTC - Average depot repair cycle time in months for CONUS locations. This is the time elapsed for a NRTS item from removal of the failed item until it is returned to depot serviceable stock. This includes the time required for base-to-depot transportation and handling and the shop flow time within the specialized repair activity required to repair the item.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None (See DRCT)
UNITS: Months
DATA SOURCE(S): AFLCR 173-10 (30)
METHOD OF DATA COLLECTION: The depot repair cycle times are listed in AFLCR 173-10, chapter 3, paragraph 3-1 (30) for various recoverable item classes. The bulk of ATE is contained in the XD3 recoverability class.

DRCTO - Average depot repair cycle time in months for overseas locations. This is the time elapsed for a NRTS item from removal of the failed item until it is returned to depot serviceable stock. This includes the time required for base to depot transportation and handling and the shop flow time within the specialized repair activity required to repair the item.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None (See DRCT)
UNITS: Months
DATA SOURCE(S): LSC Model User's Handbook
METHOD OF DATA COLLECTION: The data for this variable is not listed in AFLCR 173-10 (30) for overseas locations. The LSC model user's handbook lists the value of this variable as 57 days or 1.90 months. This is 5 days longer than for CONUS locations.

DUR - Combined utilization rate for all of a particular type like items of support equipment at depot level.

LEVEL INPUT INTO OSCATE: Support Equipment
USED IN EQUATION(S) #: 5
UNITS: Dimensionless
DATA SOURCE(S): Depot Shop
METHOD OF DATA COLLECTION: This data is not presently collected or available. This is mainly due to the secondary role of the support equipment (SE) and the somewhat random nature of the demand for the SE. The depot shop personnel or the support equipment cage may be able to provide estimates of this variable.

FICR - Average manhours spent on repair of items to be calibrated at Type I lab.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Manhours
DATA SOURCE(S): 33K-1-100 (58)
METHOD OF DATA COLLECTION: This data is available from the AGMC shop for the job order for the particular ATE.

FIICR - Average manhours spent on repair of items to be calibrated at Type II lab.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Manhours
DATA SOURCE(S): BLIS, 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is obtained from the Base Level Inquiry System (BLIS) Maintenance data for the ATE. It is obtained by dividing the sum of the manhours for the maintenance actions with action taken codes of F, G, or L and when discovered code of T by the total number of units with when discovered codes of T. Action taken and when discovered codes are listed in T.O. 51-1-06-1 (68). This data collection is for weapon systems that employ a calibration concept utilizing base Type II labs.

FIVCR - Average manhours spent on repair of items to be calibrated at Type IV lab.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Manhours
DATA SOURCE(S): BLIS, 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is collected identically as FIICR except that this would apply to weapon systems that employ a calibration concept utilizing a Type IV lab.

H - Number of pages of depot level technical orders and special repair instructions required to maintain the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 7
UNITS: Number of pages
DATA SOURCES: 0-4-6-2 (46), -4 T.O.'s, 0-1-33-( ) (65) T.O.'s
METHOD OF DATA COLLECTION: Identify applicable T.O.'s, using part numbers, from T.O. 0-4-6-2 (46). This data is also available in the -4 equipment T.O. Illustrated Parts Breakdown (IPB). The T.O. titles must then be obtained from the 0-1-33-( ) (65) series T.O.'s to determine the applicability of the T.O. to depot, intermediate, or organizational maintenance. The T.O.'s must then be researched to determine the number of pages.

IMC - Initial management cost to introduce a new line item of supply (ASSEMBLY or piece part) into the Air Force inventory.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 4
UNITS: $/Item
DATA SOURCE(S): 1979 OC-ALC/MMML cost study
METHOD OF DATA COLLECTION: This data normally available in AFLCR 173-10, chapter 4 (30) but is presently not available due to cost studies in progress to determine a more accurate value. A 1979 OC-ALC/MMML cost study has revealed initial management costs as follows:

Recoverable Item without unique parts	$1081.00
Recoverable Item with unipue parts	$1406.00
Stock Fund Item	$ 781.00

ATE generally includes both types of items. The cost for a recoverable item with unique parts should not be used because costs are computed separately for these unique parts by the PP variable. The value used for this variable should be weighted by the percentages of each type of item in the ATE. The value is computed as follows:

IMC = (percent stock fund items in the ATE)($781.00) + (percent recoverable items in the ATE)($1081.00)

Future editions of AFLCR 173-10 (30) will most probably contain management costs as listed above.

IMH - Average manhours to perform corrective maintenance of the TRU in place or on line without removal including fault isolation, repair, and verification.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 2, 6
UNITS: Manhours
DATA SOURCE(S): BLIS, 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is computed from Base Level Inquiry System (BLIS) maintenance data. The value for IMH is computed by dividing the sum of the maintenance manhours for occurrences with action taken codes of E, F, G, L, V, X, Y, Z, or H, defined in T.O. 51-1-06-1, by the sum of the units produced by these maintenance actions.

JJ - Number of pages of organizational and intermediate level technical orders required to maintain the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 7
UNITS: Number of pages
DATA SOURCE(S): 0-4-6-2 (46), 0-1-33-( ) (65)
METHOD OF DATA COLLECTION: Applicable T.O.'s can be identified in T.O. 0-4-6-2 (46) using the system, subsystem, and TRU part numbers. Applicable T.O.'s are also identified in equipment -4 T.O.'s containing the Illustrated Parts Breakdown. The T.O. titles must then be reviewed in the 0-1-33-( ) (65) series T.O.'s to determine the organizational and intermediate level T.O.'s by their titles. The individual T.O.'s must then be researched to determine the number of pages.

K - Number of line items of peculiar shop support equipment used in repair of the TRU.

LEVEL OF INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 5
UNITS: Number of line items
DATA SOURCE(S):
METHOD OF DATA COLLECTION: This data is contained in the -1 equipment T.O. in the equipment required but not supplied section.

M - Number of operating bases.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 1, 4, 5
UNITS: Number of bases
DATA SOURCE(S): D039.PH1B (Format 225)
METHOD OF DATA COLLECTION: The number of operating bases are identified in the "EAID/PCSP DATA" column of the D039.PH1B (Format 225) data report.

MRF - Average manhours per failure to complete off-equipment maintenance records.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 7
UNITS: Hours
DATA SOURCE(S): LSC Model User's Handbook
METHOD OF DATA COLLECTION: The only data source found was the value used in the LSC model user's handbook for the same variable. This value of .24 hours coincided with the value used in the developmental thesis.

MRO - Average manhours per failure to complete on-equipment maintenance records.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 7
UNITS: Hours
DATA SOURCE(S): LSC Model User's Handbook
METHOD OF DATA COLLECTION: The only data source found was the value used in the LSC model user's handbook for the same variable. This value of .08 hours coincided with the value used in the developmental thesis.

MTBF - Mean Time Between Failures in operating hours of the TRU in the operational environment.

LEVEL INPUT INTO OSCATE:
USED IN EQUATION(S) #: 1, 2, 3, 5, 6, 7
UNITS: Operating hours/failure
DATA SOURCE(S): D056B5505, SMI variable, D039.PH1B
METHOD OF DATA COLLECTION: This data is calculated by dividing the total inventory operating hours by the number of failures. The total inventory operating hours are computed by multiplying the SMI variable operating hours by the number of items in service obtained from the D039.PH1B (Format 250) data report column titled "Assets In SVC". The number of failures is defined as the number of Type 1 and 2 occurrences listed in the D056B5505 data report. Type 1 and 2 actions are defined in AFLCR 66-15, chapter 5, section B (60). Care must be taken to insure the operating hours are computed for the length of the time period covered by teh D056B5505 data report.

N - Number of different TRUs within the ATE.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 1, 2, 3, 4, 5, 6, 7, 8
UNITS: Number of TRU's
DATA SOURCES: 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is the number of TRU's assigned Work Unit Codes (WUC) in T.O. 51-1-06-1 (68).

NSYS - Number of subsystems within the ATE.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 8
UNITS: Number of subsystems
DATA SOURCE(S): 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is the number of items with an @ symbol adjacent to the assigned Work Unit Code (WUC) in T.O. 51-1-06-1 (68).

OS - Fraction of total force deployed to overseas locations.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 3
UNITS: Dimensionless
DATA SOURCE(S):
METHOD OF DATA COLLECTION: This data is computed by obtaining the number of units deployed overseas from the D039.PH1B (Format 225) data report columns (EAID/PCSP Data" and Assets in SVC" and dividing by the total number in the "Assets in Svc" column.

OST - Weighted average Order and Shipping Time in months. The elapsed time between the initiation of a request for a serviceable item and its receipt by the requesting activity. This variable is computed as follows:

OST=(OSTCON)(1-OS)+(OSTOS)(OS)

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: None (Used in program computations)
UNITS: Months
DATA SOURCE(S): Variables OSTCON, OSTOS, OS
METHOD OF DATA COLLECTION: This data is computed from the input data for the variables OSTCON, OSTOS, and OS. This data is used in the program to compute the average demands and stock levels.

OSTCON - Average order and shipping time in months for CONUS locations. This is the elapsed time between the initiation of a request for a serviceable item and its receipt by the requesting activity.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: None (see OST)
UNITS: Months
DATA SOURCE(S): AFLCR 173-10 (30), D032.ED1L
METHOD OF DATA COLLECTION: This data is contained in AFLCR 173-10, chapter 5, paragraph 5-6 (30) for 3 requisition priority groups. Survey of the requisitions in the D032.ED1L data report submitted against the F/FB-111 tape reader and the CADC test station revealed the average requisition priority was in group 2.

OSTOS - Average order and shipping time in months for overseas locations. This is the elapsed time between the initiation of a request for a serviceable item and its receipt by the requesting activity.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: None (See OST)
UNITS: Months
DATA SOURCE(S): AFLCR 173-10 (30), D032.ED1L
METHOD OF DATA COLLECTION: This data is contained in AFLCR 173-10, chapter 5, paragraph 5-6 (30) for the groups of requisition priorities. Survey of the requisitions listed in the D032.ED1L data report submitted against the F/FB-111 tape reader and the CADC test station revealed the average requisition priority was in group 2.

PAMH - Average manhours expended in place on the installed system for Preparation and Access for the TRU for example, jacking, unbuttoning, removal of other units and hookup of support equipment.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 2, 6
UNITS: Manhours
DATA SOURCE(S): Shop estimates
METHOD OF DATA COLLECTION: The data for the variable was not found to be available. The existing hour malfunction, action taken, and when discovered codes in T.O. 51-1-06-1 (68) do not provide for reporting this part of a maintenance action separately. The preparation and access is also usually accomplished in the troubleshooting process in gaining access to test points.

PIUP - Operational service life of the ATE in years. (Program Inventory Usage Period)

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 4, 5, 6, 8
UNITS: Years
DATA SOURCE(S): ATE equipment manager
METHOD OF DATA COLLECTION: The data for this variable was not found. Discussions with personnel at the ATE equipment manager, SA-ALC/MMIM, revealed ATE is usually procured with a 10 year program usage.

PMB - Direct productive manhours per man per year at base level (includes "touch time," transportation time, and setup time).

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 6
UNITS: Hours/man/year
DATA SOURCE(S): AFLCR 173-10 (30), AFM 26-3 (33)
METHOD OF DATA COLLECTION: This data is available in AFLCR 173-10, chapter 6, paragraph 6-1 (30) which was obtained from AFM 26-3, AF Manpower Standards, Volume 1, Table 2-1 (33).

PMD - Direct productive manhours per man per year at the depot (includes "touch time," transportation time, and setup time).

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 6
UNITS: Hours/man/year
DATA SOURCE(S): AFLCR 173-10 (30), AFM 26-3 (33)
METHOD OF DATA COLLECTION: This data is listed in AFLCR 173-10, chapter 6, paragraph 6-1 (30) which is obtained from AFM 26-3, AF Manpower Standards, Volume 1, table 2-1 (33).

POH - Peak Operating Hours--expected operating hours for one month during the peak usage period for the entire inventory in use.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 1, 5
UNITS: Operating hours
DATA SOURCE(S): Base maintenance analysis section
METHOD OF DATA COLLECTION: This data is not normally collected. The Base Maintenance analysis Section in the office of the Deputy Chief of Maintenance may have this data available from past or current surveys of the ATE.

PP - Number of new "P" coded consumable items within the TRU.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 4
UNITS: Number of items
DATA SOURCE(S): D049, 00-25-195 (64), AFR 66-45 (48), AFM 67-1 (67)
METHOD OF DATA COLLECTION: This data is available in the Source, Maintenance, and Recoverability (SMR) codes listed in the Illustrated Parts Breakdown of the -4 T.O. If these codes are not available, this information is available in the Master Material Supply Record (MMSR) of the D049 data system. The SMR codes are defined in T.O. 00-25-195 (64), AFR 66-45 (48), and AFM 67-1 (67).

PSC - Average packing and shipping cost to CONUS locations.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 3
UNITS: $/pound
DATA SOURCE(S): 0013.621M, AFLCR 173-10 (30)
METHOD OF DATA COLLECTION: For a rough approximation use data listed in AFLCR 173-10, chapter 5 (30) and sum transportation and packaging costs of paragraphs 5-5 and 5-8 respectively. Or compute as follows for more accurate data:

Compute transportation costs as follows:

1) obtain WT, LG, WD, DP, shipping dims data from 0013.621M for NSN, MMAC
2) determine shipping charges from TARS Guide, 0102.T9M1 data system, for the operational bases

and then add packaging costs by computing as follows:

1) obtain packaging info from 0013.622M, only certain codes needed for step 2 as follows.
2) input needed codes and additional info into Packaging Cost Computer Program (PCCP) on the CREATE computer and programmed by SA-ALC/DSPC, Kelly AFB TX.

PSO - Average packing and shipping cost to overseas locations.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 3
UNITS: $/pound
DATA SOURCE(S): 0013.621M, 0102. T9M1
METHOD OF DATA COLLECTION: Based on the weight and cube data from 0013.621M the transportation cost is computed based on the supply priority converted to a transportation priority. Supply priorities 1-8 convert to transportation priorities of 1 or 2 and are eligible for transportation by airlift and supply priorities 9-14 convert to a transportation priority of 3 and is eligible for shipment by surface modes. For airlift shipments the item is shipped from the origin to the nearest MAC channel base. The tariffs for this transportation segment are obtained from the LogAir Tariffs published by Hq AFLC/LOZ. The item is then shipped via MAC channel. The tariffs for this segment are obtained from the MAC Sequence Listing for Channel Traffic published by Hq MAC/TR, Scott AFB IL. For surface shipments, the transportation cost between the origin and post of embarkation is determined from the 0102.T9M1 TARS Guide. The tariffs for the sealift segment are contained in Instruction Pamphlet 7600.3F, Military Sealift Command Billing Rates, published by The Military Sealift Command, Washington DC. For items that weigh less than 70 lbs. and do not exceed 100 united inches for shipment are sent by parcel post regardless of the supply priority since this is the most economical and rapid method of shipment.

QPA - Quantity of like TRUs within the parent system. (Quantity per Application)

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 1, 2, 3, 5, 6, 7, 8
UNITS: Number of TRU's
DATA SOURCE(S): -4 T.O., D041.F91A
METHOD OF DATA COLLECTION: This data is available in the Illustrated Parts Breakdown (IPB) for a specific part number. The data is also available in the D041.F91A data report for repairable items. The number of different WUC's with the same part number also gives this data.

RIP - Fraction of TRU failures which can be repaired in place or on line without removal.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 1, 2, 3, 5, 6, 7
UNITS: Dimensionless (input as decimal)
DATA SOURCE(S): D041.F91A
METHOD OF DATA COLLECTION: This data is computed using the D041.F91A data report. The computation is accomplished by subtracting the Base NRTS units in the "Total Usage" column from the Base Rep Gens units in the "Total Usage" column. This value is then divided by the Base NRTS from above. In the case where there is no depot repair for the TRU, RIP=1.

RMC - Recurring management cost to maintain a line item of supply (assembly or piece part) in the wholesale inventory system.

LEVEL INPUT INTO OSCATE: System
USED WITH EQUATION(S) #: 4
UNITS: $/item/year
DATA SOURCE(S): AFLCR 173-10 (30), DSA Report
METHOD OF DATA COLLECTION: This data is normally listed in AFLCR 173-10 (30) but is presently not available. Data for this variable was found in a "Compendium of Inventory Control Point Management Information" DSA Report which resulted in a value of $337.64 in 1979 dollars.

RMH - Average manhours to fault isolate, remove, and replace the TRU on the installed system and verify restoration of the system to operational status.

LEVEL INPUT INTO OSCATE: TRU
USED WITH EQUATION(S) #: 2, 6
UNITS: Manhours
DATA SOURCE(S): BLIS
METHOD OF DATA COLLECTION: This data is computed by using BLIS data. This value is computed by summing the manhours for occurrences with action taken codes of A, B, C, D, 1 to 9, M, N, P, Q, R, S, T, U identified in T.O. 51-1-06-1 (68) and dividing by the number of units produced.

SA - Annual base supply line item inventory management cost.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 4
UNITS: $/item/year
DATA SOURCE(S): AFLMC Report 761138-3
METHOD OF DATA COLLECTION: This data was available in the Variable Cost Study (cost to add, maintain and delete), AFLMC Report 761138-3 and resulted in a value of $12.11 in 1979 dollars.

SCI - Scheduled calibration interval for the subsystem in years.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 8
UNITS: Years
DATA SOURCE(S): 33K-1-100 (58), -1 T.O.
METHOD OF DATA COLLECTION: This data is available in T.O. 33K-1-100 (58) or in the -1 equipment T.O. in the calibration requirements section.

SCMH - Manhours required to perform calibration.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None (used in program computations)
UNITS: Manhours
DATA SOURCE(S): 33K-1-100 (58)
METHOD OF DATA COLLECTION: This data is listed in T.O. 33K-1-100 (58) in the "SCH EST" column. If not listed in 33K-1-100 (58), operating base labor standards established by the MAJCOM Management Engineering Team (MET) may be available.

SMH - Average manhours to perform a scheduled periodic or phased inspection of the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 2, 6, 8
UNITS: Manhours
DATA SOURCE(S): BLIS
METHOD OF DATA COLLECTION: This data is computed from Base Level Inquiry System (BLIS) maintenance data. The manhours for occurrences with an action taken code of X and a when discovered code of M are summed and divided by the number of units produced. BLIS data must cover a sufficient inventory and time period to include several actions described about to obtain an average.

SMI - Operating hour interval between scheduled periodic or phased inspections on the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 2, 6, 7
UNITS: Operating hours
DATA SOURCE(S): 33K-1-100 (58), -1 T.O.
METHOD OF DATA COLLECTION: The operating hours between a scheduled inspection is not collected but the calendar day interval is listed in the -1 equipment T.O. and T.O. 33K-1-100 (58). The base shop or maintenance analysis action in the office of the Deputy Chief for Maintenance may have information on the average daily, weekly, etc., operating hours.

SR - Average manhours per failure to complete supply transaction records.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 7
UNITS: Manhours
DATA SOURCE(S): LSC model user's handbook
METHOD OF DATA COLLECTION: Data for this variable was only found in the LSC model user's handbook and the developmental thesis for this same variable. This value was .25 manhours.

STK - Number of spares of the ith TRU required for <u>each</u> base plus safety stock.

LEVEL INPUT INTO OSCATE: None (program computed)
USED IN EQUATION(S) #: None
UNITS: Number of TRU's/base
DATA SOURCE(S): Program computed
METHOD OF DATA COLLECTION: This data is computed for each TRU from the input data set and is output in option 7.

SYSNOUN - Name of the subsystem--up to 60 alphanumeric characters.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None (used to identify output)
UNITS: None
DATA SOURCE(S): 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is available in T.O. 51-1-06-1 (68) for the assigned WUC and also is available in the -1 equipment T.O. The data must not include any spaces or if spaces are included the data input must be enclosed by quotation marks.

TARGAVAL- Base-level spares availability objective for ATE.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: None (used in spares computations)
UNITS: Dimensionless (input as decimal)
DATA SOURCE(S): M32/808
METHOD OF DATA COLLECTION: This data is contained as an overall base maintenance organization average in the M32/808 data report under the "stockage effectiveness" "Totals" column. This is actual availability data for items which stock is authorized. A goal for availability was not found in any available data.

TCB - Cost of peculiar training per man at base level including instruction and training materials.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 6
UNITS: $
DATA SOURCE(S): Base training office
METHOD OF DATA COLLECTION: Data for the variable is found by identifying a peculiar course of training by the base shop and the cost for this training from the base training office. This is usually a formal training course.

TCD - Cost of peculiar training per man at the depot including instruction and training materials.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 6
UNITS: $
DATA SOURCE(S): Depot training office
METHOD OF DATA COLLECTION: This data is obtained by identifying peculiar training by the base shop and obtaining cost from the depot training office. This usually is in the form of a formal training course.

TD - Average cost per original page of technical documentation. The average acquisition cost of one page of the reproducible source document (does not include reproduction costs).

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 7
UNITS: $/page
DATA SOURCE(S): AFLCR 173-10 (30)
METHOD OF DATA COLLECTION: This data is available in AFLCR 173-10, chapter 5, paragraph 5-2 (30).

TE - Cost of peculiar training equipment required for the subsystem.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: 6
UNITS: $
DATA SOURCE(S): R14/902-13, -1 T.O.
METHOD OF DATA COLLECTION: This data is obtained by identifying the needed training equipment in the -1 T.O. and then obtaining the unit price from the R14/902-13 data report.

TOH - Expected Total Operating Hours for the entire inventory in use over the Program Inventory Usage Period (PIUP).

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 1, 2, 3, 6, 7
UNITS: Operating hours
DATA SOURCES: ATE Equipment Manager
METHOD OF DATA COLLECTION: This data was not found. Discussion with the ATE equipment manager indicated ATE usually acquired with the expected life of 10000 operating hours. This value is usually exceeded due to extensions in weapon system life.

TR - Average manhours per failure to complete transportation transaction forms.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 7
UNITS: Manhours
DATA SOURCE(S): LSC model user's handbook
METHOD OF DATA COLLECTION: This data was only found in the LSC model user's handbook and the developmental thesis which used a value of .16 manhours.

TRB - Annual Turnover rate for base personnel.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 6
UNITS: Dimensionless (input as decimal)
DATA SOURCE(S): E300
METHOD OF DATA COLLECTION: This data is available in the E300 Atlas program data report.

TRD - Annual Turnover rate for depot personnel.

LEVEL INPUT INTO OSCATE: System
USED IN EQUATION(S) #: 6
UNITS: Dimensionless (input as decimal)
DATA SOURCE(S): E300
METHOD OF DATA COLLECTION: This data is available in the E300 Atlas program data report.

TRUCI - Calibration interval in days for a TRU.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Days
DATA SOURCE(S): -1 T.O., 33K-1-100 (58)
METHOD OF DATA COLLECTION: This data is obtained from the -1 equipment T.O. in the calibration requirements section or T.O. 33K-1-100 (58).

TRUCMH - Manhours required to calibrate a TRU.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 8
UNITS: Manhours
DATA SOURCE(S): BLIS, 33K-1-100 (58), 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is obtained from Base Level Inquiry System (BLIS) maintenance data. This data is computed by summing the manhours for maintenance actions with action taken codes of X or J and dividing this by number of units produced. Action taken codes are defined in T.O. 51-1-06-1 (68).

TRUNOUN - Word description or name of the TRU--up to 60 alphanumeric characters.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: None (used to identify output)
UNITS: None
DATA SOURCE(S): 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is obtained from T.O. 51-1-06-1 (68) for the WUC assigned. The data input must be continuous with spaces between characters must be filled by some symbol or character, or enclose the entire input in quotation marks.

UC - Expected unit cost of the TRU at the time of initial provisioning.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 1, 3
UNITS: $
DATA SOURCE(S): CRL-1, ML-C
METHOD OF DATA COLLECTION: This data is obtained by convertint the part number to National Stock Number (NSN) using the CRL-1 data report. The unit price is then obtained from the ML-C data report for the NSN.

UEBASE - The number of unit equivalent ATE per operating base.

LEVEL INPUT INTO OSCATE:
USED IN EQUATION(S) #: None (used in stock computations)
UNITS: Number of items
DATA SOURCE(S): D039.PH1B
METHOD OF DATA COLLECTION: This data is obtained from the D039.PH1B data report from the "current applied" column for each operating base. These should be summed and then divided by the number of bases.

W - TRU installed weight in pounds.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: 3
UNITS: pounds
DATA SOURCE(S): 0013.256M, 0013.621M, 0013.255M
METHOD OF DATA COLLECTION: The installed weight is not normally available. However the shipping weight is available in the OD13.256M, 0013.621M, and 0013.255M data reports.

XSE - SE identification--up to 20 continuous alphanumeric characters.

LEVEL INPUT INTO OSCATE: Support equipment
USED IN EQUATION(S) #: None (used to identify output)
UNITS: None
DATA SOURCE(S): -1 T.O.
METHOD OF DATA COLLECTION: This data is available in the -1 equipment T.O. in the equipment required but must be a continuous string of characters up to 20 characters long. Spaces between characters must be filled by a symbol or character, or enclose the entire input in quotation marks.

XSYS - System identification. The assigned five-character alphanumeric Work Unit Code of the system.

LEVEL INPUT INTO OSCATE: Subsystem
USED IN EQUATION(S) #: None (used to identify output)
UNITS: None
DATA SOURCE(S): 51-1-06-1 (68)
METHOD OF DATA COLLECTION: This data is available in T.O. 51-1-06-1 for the assigned WUC. Maximum data input is five characters.

XTRU - TRU identification. The assigned five-character alphanumeric Work Unit Code of the TRU.

LEVEL INPUT INTO OSCATE: TRU
USED IN EQUATION(S) #: None (used to identify output)
UNITS: None
DATA SOURCE(S): 51-1-06-1 (68)
METHOD OF DATA COLLECTION: The data is available in T.O. 51-1-06-1 (68) for the assigned WUC. Maximum data input is five characters.

APPENDIX B

APPLICABLE DATA SYSTEMS AND REPORTS

DD-COMP(AR)1092

Civilian Manpower and Funding Report
DCS: DD-COMP(AR)1092
AFLC OPR: ACB
DIRECTIVES: AFM 172-1 (66)
AFM 67-1, Vol. I, Part 3 (67)
CODES DATA LISTED BY: OBAN

DATA ORDERING SEQUENCE: This data is listed by Operating Budget Account Number (OBAN) identified for specific activities in AFM 300-4, Vol. X, part 3 (41).

D039.PH1A

Projected Requirements/Assets Summary (Format 250)
RCS: LOG-MMR(Q)7126
AFLC OPR: ACDSS and LORRS
DIRECTIVES: AFLCR 171-250 (45)
AFLCR 57-2 (40)
CODES DATA LISTED BY: ALC, DIV, IM, I&S Master No.

DATA ORDERING SEQUENCE: The data listed in this report is listed by ALC code, ALC Division code, Item Manager (IM) code, and by I&S master number. The ALC code consists of the abbreviation of the responsible AFLC Air Logistics Center (ALC) (i.e. SA-ALC, WR-ALC). The ALC Division and IM codes are available at the responsible ALC in printouts of locally prepared tapes of locally assigned codes. The manager designator code used at the ALC's consists of three alphabetic characters such as EGQ. The first letter is the Division code and indicates the particular section the IM is located in. The last two letters are the IM code and indicate a particular individual. The I&S master number is the NSN of the item this part is grouped with for interchangeability and substituteability. This number is listed in the local listing along with the other codes. This listing is numerical by NSN and the MMAC code of the NSN. The MMAC code is the two alphabetic letters added to the end of some NSN's.

D039.PH1B

Base/Organization/Type Requirements/
Assets Data (Format 225)
RCS: LOG-MMR(Q) 7128
AFLC OPR: ACDSS and LORRS
DIRECTIVES: AFLCR 171-250 (45)
AFLCR 57-2 (40)
CODES DATA LISTED BY: Same as D039.PH1A

DATA ORDERING SEQUENCE: Same as D039.PH1A. This report complements the D039.PH1A summary report.

D039.PH1C

Reported Assets/Requirements Details
(Format 100)
RCS: None
AFLC OPR: ACDSS and LORRS
DIRECTIVES: AFLCR 171-250 (45)
AFLCR 57-2 (40)
CODES DATA LISTED BY: Same as D039.PH1A

DATA ORDERING SEQUENCE: Same as D039.PH1A. This report complements the D039.PH1A summary report.

D041.F91A

Factors Print Out
RCS: None
AFLC OPR: ACDSS and LORRS
DIRECTIVES: AFLCR 171-4 (63)
AFLCM 57-3 (39)
CODES DATA LISTED BY: ALC Division Code, Equipment Specialist Code, and NSN.

DATA ORDERING SEQUENCE: This data is listed by Division code, by Equipment Specialist code and NSN in this sequence. The Division code and Equipment Specialist code are listed in locally prepared tapes at the ALC. These codes are identified to an NSN.

D041.F92A

Usage Printout
RCS: None
AFLC OPR: ACDSS and LORRS
DIRECTIVES: AFLCR 171-4 (63)
AFLCM 57-3 (39)
CODES DATA LISTED BY: Same as D041.F91A

DATA ORDERING SEQUENCE: Same as D041.F91A

D049.441A

Full Range List
RCS: None
AFLC OPR: ACDSS and LORES
DIRECTIVES: AFLCR 171-73 (57)
AFLCR 65-1 (56)
DOD 4140-32 (74)
CODES DATA LISTED BY: ALC code, Division Code, Equipment Specialist Code, NSN

DATA ORDERING SEQUENCE: This data is listed by ALC code, Division, Equipment Specialist codes and NSN in this sequence. The ALC code is the ALC abbreviation such as SA-ALC, WRALC. The Division and Equipment Specialist codes are available at the ALC from locally prepared tapes.

D056B5505

Summarized Maintenance Actions for Selected Work Unit Codes
RCS: LOG-MMO(AR)7169
AFLC OPR: ACDSS and LOLMA
DIRECTIVES: AFLCR 171-45 (61)
AFLCM 66-15 (60)
AFR 66-30 (59)
CODES DATA LISTED BY: ALC, EAD, WUC

DATA ORDERING SEQUENCE: This data is listed by ALC code, End Article Designator (EAD) code, and Work Unit code (WUC) in this sequence. The ALC code is the abbreviation of the prime ALC (i.e. SA-ALC, SM-ALC). The EAD code is found by identifying the Standard Reporting Designator (SRD) for the part number of the ATE system in T.O. 00-20-2 (50). The EAD is then found in the in data report D056A-023-AW-M02 (A9 table) by ALC code and SRD.

E300

Atlas Stat Summary Inquiries
RCS: None
AFLC OPR: ACDSS and DPCP
DIRECTIVES: AFM 171-130 (36)
AFM 30-130 (37)
CODES DATA LISTED BY: Office symbol

DATA ORDERING SEQUENCE: This data is listed by office symbol.

G019CJE11

MISTR IM Projected Workload Report
RCS: None
AFLC OPR: ACDSS and MASR
DIRECTIVES: AFLCR 171-296 (55)
AFLCR 65-12 (54)
CODES DATA LISTED BY: ALC Division, Master I&S Number

DATA ORDERING SEQUENCE: This data is listed by ALC Division and master I&S number in this sequence. These codes are found in locally prepared tape listings at the ALC by NSN.

G019CJ016

MISTR IM Projected Workload Industrial Specialist Report
RCS: None
AFLC OPR: ACDSS and MASR
DIRECTIVES: AFLCR 171-296 (55)
AFLCR 65-12 (54)
CODES DATA LISTED BY: Industrial Specialist code, Master I&S Number

DATA ORDERING SEQUENCE: This data is listed by Industrial Specialist code and the Master I&S number in this sequence. These codes are both found in separate ALC locally prepared tape listings. The master I&S number is found in one listing by NSN. The Industrial Specialist code is found in the locally prepared listing by Federal Stock Class (FSC)(e.g. first four digits of NSN) and MMAC code (e.g. two letters added to some NSN's).

HAF-ACF(M)7107

AFIF Monthly Trial Balance and Schedule
RCS: HAF-ACF(M)7107
AFLC OPR: ACDSS and ACFFC
DIRECTIVES: AFR 170-12 (34)
AFLCR 170-10 (43)
AFLCM 171-347 (44)
CODES DATA LISTED BY: GLAC

DATA ORDERING SEQUENCE: This data is listed by the General Ledger Accounting code (GLAC) listed in AFR 170-12 (34) and AFLCR 170-10 (43).

CRL-1	Master Cross Reference List RCS: None OPR: Defense Logistics Service Center, Battle Creek, Michigan DIRECTIVES: DOD4130.2-M (75) CODES DATA LISTED BY: Part number DATA ORDERING SEQUENCE: This data is listed by part number and the associated NSN is obtained.
ML-C	Consolidated Management Data List RCS: None OPR: Defense Logistics Service Center, Battle Creek Michigan DIRECTIVES: DOD4130.2-M (75) CODES DATA LISTED BY: NSN DATA ORDERING SEQUENCE: This data is listed by NSN.
M32/808	Monthly Base Supply Management Report Part 2 RCS: HAF-LGY(M)7130 OPR: Base Accounting and Finance Office DIRECTIVES: AFM 67-1, Vol. 2, part 2, chapter 24 (67) CODES DATA LISTED BY: Areas of evaluation of supply DATA ORDERING SEQUENCE: This data are summarizations of stockage effectiveness and the overall operations of base supply.
P005C	AFLC Automated Reports Management System RCS: None AFLC OPR: ACDSS and ACRM DIRECTIVES: AFLCR 171-280 (29) AFR 178-7 (51) AFLC Supplement 1 (52) CODES DATA LISTED BY: RCS, DSD DATA ORDERING SEQUENCE: This system contains several parts providing cross reference between RCS, DSD, directives, and keywords of these data reports.

P040E

Data Systems Assignments and Status Master List
RCS: None
AFLC OPR: ACDSS and ACDRA
DIRECTIVES: AFLCM 171-351 (35)
CODES DATA LISTED BY: DSD

DATA ORDERING SEQUENCE: This data is listed by Data System Designator (DSD).

APPENDIX C

STEPS IN EXERCISING THE OSCATE MODEL

This Appendix describes the techniques for exercising the LSC model on the AFLC Computational Resources for Engineering and Simulations, Training, and Education (CREATE) computer system using the time-sharing (TSS) mode on a CREATE remote terminal. In order to exercise the model, the OSCATE program must be transfered to your current file and a data file must be established. These requirements and the steps in running the program are discussed below.

<u>Data file establishment</u>. A direct access file containing values for the model variables must be established. This file will be linked with the OSCATE program during execution. The data file format is shown in figure C-1. Figures C-2 through C-5 may be used for compilation of data for input into the data file. Fig. 6 (p. 54) depicts an example data file construction. The data file is read into the OSCATE program using a variable or "free" format which simplifies input of data into the file. This input format requires a space or comma between input data. Therefore input of character strings for the variables XSE, SYSNOUN, and TRUNOUN require spaces between words to be filled by a symbol or character such as an underline bar. Blanks may be input if quotation marks are used to enclose the character string. The sequence of Figure C-1 must be followed and line numbers must be used. The data file may be

constructed on any system such as FORTRAN or CARDIN. Each data file line must begin with a line number and there must be a non-blank value for each and every variable in that line. Zero values must be included where appropriate. The data file must be given a file name and saved on your user ID number storage. The data file should be carefully checked for errors prior to use in running the OSCATE program.

Transfering OSCATE to current file. The TSS source version of OSCATE exists under USER ID 38BAD with file name OSCATE. To access the program, the TSS question/answer sequence is:

```
SYSTEM? FORT
OLD OR NEW?  OLD 38BAD/OSCATE, R
READY
*
```

OSCATE is then available on your current file to use as is or modify. You should assign a unique file name to your copy of OSCATE and save it on your USER ID.

Exercising the model. If your USER ID catalog contains a copy of OSCATE it may be run by the following command:

```
*RUN  OSCATE # (your data file name) "10"
```

The program will then compute the total Logistic Support Cost for the ATE under evaluation followed by an interactive question/answer sequence which will describe the available output options which includes program termination.

Level	Variables
SYSTEM	LN* TOH POH PIUP M OS NSYS UEBASE TARGAVAL LN*OSTCON OSTOS IMC RMC PSC PSO TRB TRD LN*TD SA MRO MRF SR TR PMB PMD CARF
SUBSYSTEM	LN*XSYS SYSNOUN LN*BCA DCA DPA N LN*H JJ SMH SMI TCB TCD TE LN*BLR DLR DMR DAA DRCTC DRCTO LN*SCI SCMH CIVLR CASYS
TRU	LN*XTRU TRUNOUN LN*QPA UC MTBF RIP DCOND DMC LN*PAMH IMH RMH DBCMH DMH W PP K LN*TRUCI TRUCMH CILR CIILR FICR CI CII CIV FIICR FIVCR CATRU
SUPPORT EQUIPMENT	LN*XSE CAD COD CUR DOWN

*LN is the data line number in the data file.

FIG. C-1 DATA FILE FORMAT

FIG. C-2 SYSTEM DATA INPUT FORMAT

IDENT: NOUN:

VARIABLES

*LN	TOH	POH	PIUP	M	OS	NSYS	UEBASE	TARGAVAL.	
-------	-------	-------	-------	-----	-----	-----	------	------	
*LN	OSTCON	OSTOS	IMC	RMC	PSC	PSO	TRB	TRD	
-------	-------	-------	-------	-----	-----	-----	------	------	
*LN	TD	SA	MRO	MRF	SR	TR	PMB	PMD	CARF
-------	-------	-------	-------	-----	-----	-----	------	------	------

*LN is the data line number in the data file.

FIG. C-3 SUBSYSTEM DATA INPUT FORMAT

IDENT:				NOUN:			
VARIABLES							
*LN	XSYS	SYSNOUN					
-------	-------	---					
*LN	BCA	DCA	DPA	N			
-------	-------	-------	-------	-------			
*LN	H	JJ	SMH	SMI	TCB	TCD	TE
-------	-------	-------	-------	-------	-------	-------	----------
*LN	BLR	DLR	DMR	DAA	DRCTC	DRCTO	
-------	-------	-------	-------	-------	-------	-------	
*LN	SCI	SCMH	CIVLR	CASYS			
-------	-------	-------	-------	-------			

*LN is the data line number in the data file.

FIG. C-4 TRU DATA INPUT FORMAT

WUC: NOUN:

VARIABLES

*LN	XTRU	TRUNOUN (Remember to enclose with " if spaces included)										
-------	-------	---										
*LN	QPA	UC	MTBF	RIP	DCOND	DMC						
-------	-------	-------	-------	-------	-------	-------						
*LN	PAMH	IMH	RMH	DBCMH	DMH	W	PP	SP	K			
-------	-------	-------	-------	-------	-------	----	-----	----	----			
*LN	TRUCI	TRUCMH	CILR	CIILR	FICR	CI	CII	CIV	FIICR	FIVCR	CATRU	
-----	-----	------	-----	-----	----	----	----	----	-----	-----	-----	

*LN is the data line number in the data file.

FIG. C-5 SUPPORT EQUIPMENT DATA INPUT FORMAT

WUC:			NOUN:		
VARIABLES					
*LN	XSE	CAD	COD	DUR	DOWN
-------	-------	-------	-------	-------	-------
*LN	XSE	CAD	COD	DUR	DOWN
-------	-------	-------	-------	-------	-------
*LN	XSE	CAD	COD	DUR	DOWN
-------	-------	-------	-------	-------	-------
*LN	XSE	CAD	COD	DUR	DOWN
-------	-------	-------	-------	-------	-------
*LN	XSE	CAD	COD	DUR	DOWN
-------	-------	-------	-------	-------	-------

*LN is the line number in the data file. Only K (TRU variable) of these lines are input for each TRU and must follow each TRU data input.

APPENDIX D

TAPE READER DATA SET

```
0011  76250  1040  11  2  0  1  5  .78
0012  .394  0  1033.63  337.64  .94  0  .4025  .26
0013  201.23  12.11  .08  .24  .25  .16  1728  1728  0
0021  PALDO  4920-00-764-0128DQ__PUNCHED_TAPE_READER_FB-111
0022  5475.00  286950.00  0  18
0023  0  75  .75  13.3  0  0  0
0024  16.42  24.997  1.10  168  1.73  2.07
0025  0  0  16.42  0
0101  PALCB/D  4920-00-463-1096DQ__READER_PUNCHED_TAPE
0102  2  14940.76  19365  .14  0  .016
0103  0  8.5  .93  9.25  27.75  95.00  20  0
0104  0  0  32.454  16.42  0  0  0  0  0  0  0
0201  PALCG  4920-00-166-8990DQ__HUD
0202  1  474.37  77458  1  0  0
0203  0  11.024  0  0  0  1.00  0  0
0204  0  0  32.454  16.42  0  0  0  0  0  0  0
0301  PALCL  5930-00-413-0661EW__SWITCH
0302  1  18.20  77458  1  0  0
0303  0  11.024  0  0  0  0.50  0  0
0304  0  0  32.454  16.42  0  0  0  0  0  0  0
0401  PALCN  5895-00-420-3220ZR__MOTOR_DRIVER
0402  1  526.30  19364  1  0  0
0403  0  1.167  0  0  0  5.00  0  0
0404  0  0  32.454  16.42  0  0  0  0  0  0  0
0501  PALCP  6625-00-760-7796____AMP._PHOTOCELL
0502  1  420.00  7745  1  0  .043
0503  0  1.083  0  1.83  5.47  1.00  1  0
0504  0  0  32.454  16.42  0  0  0  0  0  0  0
0601  PALCQ  6625-00-450-2020DQ__MOTOR_SEQ._CONTROL
0602  1  678.70  7745  .02  .012  .043
0603  0  1.67  0  1.90  5.70  0.75  1  0
0604  0  0  32.454  16.42  0  0  0  0  0  0  0
0701  PALFO  4920-00-567-7853DQ__CABLE_SPECIAL_PURP.
0702  1  2241.99  38729  1  0  0
0703  0  11.024  0  0  0  11.00  2  0
0704  0  0  32.454  16.42  0  0  0  0  0  0  0
0801  PALGO  4920-00-469-9160DQ__CONTROLLER_TR
0802  1  1003.00  77458  1  0  0
0803  0  11.024  0  0  0  3.00  0  0
0804  0  0  32.454  16.42  0  0  0  0  0  0  0
0901  PALJA  4920-00-410-6914DQ__MODULE_CONTROLLER
0902  1  265.80  38729  0  0  .137
0903  0  0  3.25  1.63  4.87  1.00  16  0
0904  0  0  32.454  16.42  0  0  0  0  0  0  0
1001  PALJB  4920-00-410-6915DQ__MODULE_LINE_DRIVER
1002  1  598.00  38729  1  0  .135
1003  0  1  0  2.05  6.15  1.00  12  0
1004  0  0  32.454  16.42  0  0  0  0  0  0  0
```

```
1101  PALJC/D  4920-00-410-6916DQ__MODULE_LINE_RECEIV.
1102  2  265.80  38729  1  0  .101
1103  0  1  0  1.88  5.62  1.25  3  0
1104  0  0  32.454  16.42  0  0  0  0  0  0  0
1201  PALJE  4920-00-152-2273DQ__MODULE
1202  1  308.00  19364  0  0  .014
1203  0  0  1  1.93  5.77  0.75  5  0
1204  0  0  32.454  16.42  0  0  0  0  0  0  0
1301  PALKO  4920-00-464-3025DQ__LINE_DRIVE_CIRC.
1302  1  1098.10  38729  .14  0  0
1303  0  7.77  3.25  0  0  0.25  0  0
1304  0  0  32.454  16.42  0  0  0  0  0  0  0
1401  PALLO  4920-00-464-3026DQ__CONTROL_AMP._CIRC.
1402  1  478.10  77458  0  0  0.043
1403  0  0  3.25  1.83  5.47  0.25  5  0
1404  0  0  32.454  16.42  0  0  0  0  0  0  0
1501  PALMO  4920-00-464-3027DQ__DECODE_CIRCUIT
1502  1  637.50  9682  0  0  0.043
1503  0  0  1  2.5  7.5  0.32  7  0
1504  0  0  32.454  16.42  0  0  0  0  0  0  0
1601  PALNO  4920-00-494-8631DQ__LAMP_DRIVER_CIRCUIT
1602  1  2278.00  38729  0  0  0.043
1603  0  0  1  1.83  5.47  0.32  20  0
1604  0  0  32.454  16.42  0  0  0  0  0  0  0
1701  PALPO  4920-00-494-8632DQ__LAMP_DRIVER_BUFFER
1702  1  388.70  77458  1  0  0
1703  0  11.024  0  0  0  0.29  0  0
1704  0  0  32.454  16.42  0  0  0  0  0  0  0
1801  PALRO  4920-00-195-4154DQ__CABLE_ASSY.
1802  1  3063.23  77458  1  0  0
1803  0  11.024  0  0  0  7.00  0  0
1804  0  0  32.454  16.42  0  0  0  0  0  0  0
```

APPENDIX E

CADC TEST STATION DATA SET

```
0001  31240  286  11  2  0  1  1  .78
0002  .394  0  925.44  337.64  .41  0  .4025  .26
0003  201.23  12.11  .08  .24  .25  .16  1728  1728  .25
0011  PAJOO  4920-00-460-0397DQ__CADC_TEST_STA_FB-111
0012  21820.00  31320.00  0  26
0013  0  979  32.0  710  0  0  0
0014  16.42  24.997  1.10  168  1.73  2.07
0015  .5  14  16.42  1
0101  PAJBA  4920-00-342-0844DQ__OSCILLATOR
0102  1  388.90  45440  1  0  0
0103  0  14.55  0  0  0  4.00  2  0
0104  90  7.5  32.454  16.42  0  0  0  0  15.5  0  0
0201  PAJBB  4920-00-109-8333DQ__POWER_SUPPLY
0202  1  2888.00  11360  .75  0  .023
0203  0  14.55  0  7.65  22.95  91.00  10  0
0204  90  7.5  32.454  16.42  0  0  1  0  27.53  0  1
0301  PAJCA  4920-00-136-0022DQ__ANGLE_POS._IND.
0302  1  8137.00  11360  1  0  .060
0303  0  14.55  0  18.98  56.92  56.0  20  0
0304  180  8  32.454  16.42  0  0  1  0  8  0  1
0401  PAJCB  4920-00-135-5408DQ__CIRC._CARD_PWR._SUPP.
0402  1  435.05  45440  1  0  0
0403  0  14.55  0  0  0  1.0  0  0
0404  0  0  32.454  16.42  0  0  0  0  0  0  0
0501  PAJDA  4920-00-432-5330DQ__RELAY_DRIVER
0502  1  841.05  45440  1  0  0
0503  0  14.55  0  0  0  0.69  0  0
0504  0  0  32.454  16.42  0  0  0  0  0  0  0
0601  PAJDB  6625-00-403-0103DQ__DEMODULATOR
0602  1  401.99  45440  1  0  0
0603  0  14.55  0  0  0  0.50  0  0
0604  0  0  32.454  16.42  0  0  0  0  0  0  0
0701  PAJDD  4920-00-449-2888DQ__COUNTER
0702  1  377.05  22720  1  0  0
0703  0  14.55  0  0  0  0.50  0  0
0704  0  0  32.454  16.42  0  0  0  0  0  0  0
0801  PAJDE  4920-00-449-2887DQ__DECODER
0802  1  509.14  45440  1  0  0
0803  0  14.55  0  0  0  0.50  0  0
0804  0  0  32.454  16.42  0  0  0  0  0  0  0
0901  PAJDF  4920-00-242-8715____SWITCH_QUAD.
0902  1  1441.51  45440  1  0  0
0903  0  14.55  0  0  0  1.00  0  0
0904  0  0  32.454  16.42  0  0  0  0  0  0  0
1001  PAJGA  4140-01-043-5035____BLOWER_MOTOR
1002  1  319.55  22720  1  0  0
1003  0  14.55  0  0  0  10.00  0  0
1004  0  0  32.454  16.42  0  0  0  0  0  0  0
```

```
1101  PAJHA  4920-00-192-1109DQ__COMPARATOR_DIGITAL
1102  1  5542.00  5680  .46  0  0
1103  0  14.55  0  0  0  31.00  0  0
1104  0  0  32.454  16.42  0  0  0  0  0  0  0
1201  PAJHB  4920-00-136-0124DQ__COMPAR._BOARD
1202  1  504.86  11360  1  0  0
1203  0  14.55  0  0  0  0.41  0  0
1204  0  0  32.454  16.42  0  0  0  0  0  0  0
1301  PAJHC  4920-00-136-0128DQ__PWR._SUPP._PC_BOARD
1302  1  276.94  11360  .44  0  .068
1303  0  14.55  0  1.45  4.35  0.50  6  0
1304  0  0  32.454  16.42  0  0  0  0  0  0  0
1401  PAJHE  4920-00-136-0127DQ__RELAY_BOARD_PC
1402  1  672.46  45440  1  0  0
1403  0  14.55  0  0  0  0.94  0  0
1404  0  0  32.454  16.42  0  0  0  0  0  0  0
1501  PAJHF  4920-00-136-0125DQ__STORAGE_BOARD_PC
1502  1  504.86  7573  1  0  0
1503  0  14.55  0  0  0  0.75  0  0
1504  0  0  32.454  16.42  0  0  0  0  0  0  0
1601  PAJHG  4920-00-192-1012DQ__GATE_RESET_BOARD_PC
1602  1  287.17  45440  1  0  0
1603  0  14.55  0  0  0  0.41  0  0
1604  0  0  32.454  16.42  0  0  0  0  0  0  0
1701  PAJJB  6625-00-167-9581____10K_DECADE
1702  1  168.05  45440  1  0  0
1703  0  14.55  0  0  0  0.69  0  0
1704  90  4  32.454  16.42  0  0  1  0  2  0  1
1801  PAJJC  6625-00-167-9582____STD._DECADE
1802  1  258.00  45440  1  0  0
1803  0  14.55  0  0  0  1.25  0  0
1804  90  4  32.454  16.42  0  0  1  0  2  0  1
1901  PAJKA  4920-00-450-4376DQ__RESISTOR_MODULE
1902  1  3074.53  45440  1  0  0
1903  0  14.55  0  0  0  1.10  0  0
1904  0  0  32.454  16.42  0  0  0  0  0  0  0
2001  PAJKB  4920-00-401-5467DQ__DRIVER_MODULE
2002  1  1902.20  45440  1  0  0
2003  0  14.55  0  0  0  1.00  0  0
2004  0  0  32.454  16.42  0  0  0  0  0  0  0
2101  PAJKE  4920-00-722-7899DQ__BOARD_ASSY._DE
2102  1  139.17  45440  1  0  0
2103  0  14.55  0  0  0  1.25  0  0
2104  0  0  32.454  16.42  0  0  0  0  0  0  0
2201  PAJKF  4920-00-726-2262DQ__BOARD_ASSY._DE
2202  1  53.04  22720  1  0  0
2203  0  14.55  0  0  0  0.13  0  0
2204  0  0  32.454  16.42  0  0  0  0  0  0  0
```

```
2301  PAJLA  4920-00-450-6077DQ__PHOTO_BLK._TR
2302  1  4857.00  45440  1  0  .030
2303  0  14.55  0  13.10  39.3  88.00  20  0
2304  0  0  32.454  16.42  0  0  0  0  0  0  0
2401  PAJLB  4920-00-116-4167DQ__CONT_UNIT_CU80
2402  1  459.90  45440  1  0  0
2403  0  14.55  0  0  0  0.82  0  0
2404  0  0  32.454  16.42  0  0  0  0  0  0  0
2501  PAJLC  4920-00-135-5339DQ__MODULE
2502  1  182.49  45440  1  0  0
2503  0  14.55  0  0  0  0.29  0  0
2504  0  0  32.454  16.42  0  0  0  0  0  0  0
2601  PAJTD  4920-01-046-1604BJ__FIXT._HOLD_CADC
2602  1  1500.00  45440  1  0  0
2603  0  14.55  0  0  0  10.00  0  0
2604  0  0  32.454  16.42  0  0  0  0  0  0  0
```

APPENDIX F

CORRECTED OSCATE PROGRAM

```
1000*#RUN *=(CORE=30K)
1010C************************************
1020C************** OSCATE *************
1030C************************************
1031C####################################
1032C######### UPDATED JUNE 1980 #######
1033C####################################
1034C#### PER AFIT THESIS LSSR 46-80 ####
1035C####################################
1036C### LINE NOS 1100 & 1610 MODIFIED ##
1037C####################################
1038C##### TO CORRECT FORMAT ERRORS #####
1039C####################################
1040      DIMENSION TRUMAT(100,20),SEMAT(100,9),SYSMAT(30,15),SECUM(50,5)
1050      DIMENSION SORTRU(100,20),EQTOT(12),AVTAB(1000,5),UCTAB(100)
1060      DIMENSION KEY(1),NODE(1),LINK(1000),SETAB(50,2)
1070      CHARACTER XSYS*5(30),XTRU*5(100,2),XSE*20(100),SORTXTRU*5(100,2)
1080      CHARACTER SYSNOUN*60(30),TRUNOUN*60(100),SETRU*5(100,2),CANS*5
1090      CHARACTER XSECUM*20(50),DATE*8,CMAT*5(1,1)
1100     DATA SYSMAT/450*0./,TRUMAT/2000*0./,EQTOT/12*0./
1110      REAL H,INC,INH,JJ,LS,M,MRO,MRF,MTBF
1120 CALL FPARAM(1,80)
1130      TOTLSC=0.
1140      AVI=1.
1150      NUMAVT=0
1160      MAXAVT=1000
1170C****************************************
1180C********** READ ATE VARIABLES *********
1190C****************************************
1200      READ(10,2) LN, TOH,POH,PIUP,M,OS,NSYS,UEBASE,TARGAVAL
1210      READ(10,2) LN, OSTCON,OSTOS,INC,RMC,PSC,PSO,TRB,TRD
1220      READ(10,2) LN, TD,SA,MRO,MRF,SR,TR,PMB,PMD,CARF
1230    2 FORMAT(V)
1240      OST=OSTCON*(1.-OS)+OSTOS*OS
1250      IF(NSYS.LE.30) GO TO 30
1260      PRINT 3
1270    3 FORMAT("REDIMENSION SYSMAT, XSYS, SYSNOUN")
1280      STOP
1290   30 INEXT=1
1300      JNEXT=1
1310C********************************************
1320C************ READ SYSTEM VARIABLES *********
1330C********************************************
1340      DO 1000 IS=1,NSYS
1350      READ(10,2) LN,XSYS(IS),SYSNOUN(IS)
1360      READ(10,2) LN,BCA,DCA,DPA,N
1370      READ(10,2) LN,H,JJ,SMH,SMI,TCB,TCD,TE
1380      READ(10,2) LN,BLR,DLR,DMR,DAA,DRCTC,DRCTO
1390      READ(10,2) LN,SCI,SCMH,CIVLR,CASYS
```

```
      DRCT=DRCTC*(1.-OS)+DRCTO*OS
      SYSMAT(IS,2)=TOH*SMH*BLR/SMI
      SYSMAT(IS,5)=(1+0.1*PIUP)*(DCA+DPA+N*BCA)
      C6X=TCB*(1.+(PIUP-1.)*TRB)/(PIUP*PMB)
      C6Y=TCD*(1.+(PIUP-1.)*TRB)/(PIUP*PMB)
      SYSMAT(IS,6)=C6X*TOH*SMH/SMI+TE
      SYSMAT(IS,7)=TOH*BLR*(MRO+0.1*(SR+TR))/SMI+TD*(JJ+N)
      IF(CASYS.EQ.0) GO TO 34
       SYSMAT(IS,8)=365*PIUP*CIVLR/SCI
   34 IF(N.EQ.0) GO TO 1000
C****************************************
C********* READ TRU VARIABLES **********
C****************************************
      IMAX=INEXT+N-1
      IF(IMAX.LE.100) GO TO 38
      PRINT 37
  37  FORMAT("REDIMENSION TRUMAT,XTRU,TRUNOUN,SORTRU,SORTXTRU,KC,KD,KE")
      STOP
   38 DO 999 I=INEXT,IMAX
      READ(10,2) LN,XTRU(I,1),TRUNOUN(I)
      READ(10,2) LN,QPA,UC,MTBF,RIP,DCONB,DMC
      READ(10,2) LN,PAMH,IMH,RMH,DBCMH,DMH,W,PP,K
     READ(10,2) LN,TRUCI,TRUCMH,CILR,CIILR,FICR,CI,CII,CIV,
&      FIICR,FIVCR,CATRU
      IF(CATRU.EQ.0) GO TO 39
     CAL1=365*PIUP*QPA*TRUCMH*((CI*CILR+CII*CIILR+
&    CIV*CIVLR)/TRUCI)
     CAL2=365*PIUP*QPA*CARF*((CI*CILR*FICR+CII*CIILR*FIICR+
&    CIV*CIVLR*FIVCR)/TRUCI)
     TRUMAT(I,20)=CAL1+CAL2
  39  XTRU(I,2)=XSYS(IS)
      PKGEN=POH*QPA/MTBF
      TRUMAT(I,9)=PKGEN
      PKOEGEN=PKGEN*(1.-RIP)
      TRUMAT(I,10)=PKOEGEN
      TOTGEN=TOH*QPA/MTBF
      TRUMAT(I,11)=TOTGEN
      TOTOEGEN=TOTGEN*(1.-RIP)
      TRUMAT(I,12)=TOTOEGEN
      DMDMEAN=PKOEGEN*OST/M
      TRUMAT(I,14)=DMDMEAN
C************************************************************
***COMPUTE MIN BASE TRU SPARES STOCK LEVELS SUCH THAT***
*** EACH TRU HAS AN AVAILABILITY>=TARGAVAL. COMPUTE ***
*** ADD`L INFO REQUIRED FOR MARGINAL ANALYSIS "BUYS."  ***
************************************************************
      XBO=DMDMEAN
      PROBX=EXP(-DMDMEAN)
```

```
      STK=0.
      STKI=0.
      SUM=0.
      UCTAB(I)=UC
      AVO=(1.-XBO/(QPA*UEBASE))**QPA
      AVI=AVI*AVO
      AV=AVO
      TRUMAT(I,17)=0
      TRUMAT(I,15)=XBO
      TRUMAT(I,16)=AV
 41 IF(AV.GT.0.99999) GOTO 45
      SUM=SUM+PROBX
      XBO=XBO+SUM-1.
      STK=STK+1.
      PROBX=PROBX*DMDMEAN/STK
      AV=(1.-XBO/(QPA*UEBASE))**QPA
      RIMP=AV/AVO
      SV=ALOG(RIMP)/UC
      AVO=AV
      IF(AV .GT. TARGAVAL) GO TO 42
      STKI=STKI+1.
      AVI=AVI*RIMP
      TRUMAT(I,15)=XBO
      TRUMAT(I,16)=AV
      GO TO 41
   42 NUMAVT=NUMAVT+1
      IF(NUMAVT .LE. MAXAVT) GO TO 44
      PRINT 43
   43 FORMAT("REDIMENSION AVTAB, LINK AND RESET MAXAVT")
      STOP
   44 AVTAB(NUMAVT,1)=SV
      AVTAB(NUMAVT,2)=RIMP
      AVTAB(NUMAVT,3)=FLOAT(I)
AVTAB(NUMAVT,4)=XBO
AVTAB(NUMAVT,5)=AV
GOTO 41
 45  TRUMAT(I,17)=STKI
      DPIPE=CEIL(PKOEGEN*(1-DCOND)*DRCT)
      TOTCOND=CEIL(TOTOEGEN*DCOND)
      TRUMAT(I,18)=DPIPE
      TRUMAT(I,19)=TOTCOND
      TRUMAT(I,1)=UC*(STKI*M+DPIPE+TOTCOND)
      TRUMAT(I,2)=TOTGEN*(PAMH+RIP*IMH+(1.-RIP)*RMH)*BLR
      TRUMAT(I,3)=TOTOEGEN*((DBCMH*DLR+(1-DCOND)
&     *DMH*(BLR+DMR)+DMC*UC)+2*((1.-OS)*PSC+OS*PSO)*1.35*U)
      TRUMAT(I,4)=(IMC+PIUP*RMC)*(1.+PP)+M*SA*PIUP
 47  TRUMAT(I,6)=C6X*TOTGEN*(PAMH+RIP*IMH+(1.-RIP)*RMH)+
&     C6Y*TOTOEGEN*(DBCMH+(1.-DCOND)*DMH)
      TRUMAT(I,7)=TOTGEN*(MRO+(1.-RIP)*(SR+TR))*BLR
```

```
      IF (K.EQ.0) GO TO 999
C****************************************
C********** READ SE VARIABLES **********
C****************************************
      JMAX=JNEXT+K-1
      IF(JMAX.LE.100) GO TO 49
      PRINT 48
   48 FORMAT("REDIMENSION SEMAT,XSE,SETRU")
      STOP
   49 DO 998 J=JNEXT,JMAX
      READ(10,2) LN,XSE(J),CAD,COD,DUR,DOWN
      SETRU(J,1)=XTRU(I,1)
      SETRU(J,2)=XTRU(I,2)
      SEMAT(J,5)=PKOEGEN*(DBCMH+(1-DCOND)*DMH)/(DUR*DAA*(1.-DOWN))
      SEMAT(J,7)=CAD
      SEMAT(J,9)=COD
  998 CONTINUE
      JNEXT=JNEXT+K
  999 CONTINUE
      INEXT=INEXT+N
 1000 CONTINUE
***********************************************
*** "BUY" ADDITIONAL SPARES SO THAT PRODUCT ***
*** AVAILABILITY FOR ALL TRUS>=TARGAVAL ***
***********************************************
      KEY(1)=1
      MODE(1)=2
    CALL SORTL(AVTAB,NUMAVT,5,KEY,MODE,1,MAXAVT,1,LINK,CMAT,1,0)
      NUMPTR=0
   60 IF(AVI .GT. TARGAVAL) GO TO 65
      NUMPTR=NUMPTR+1
      RIMP=AVTAB(NUMPTR,2)
      IFLUPT=AVTAB(NUMPTR,3)
      TRUMAT(IFLUPT,15)=AVTAB(NUMPTR,4)
      TRUMAT(IFLUPT,16)=AVTAB(NUMPTR,5)
      TRUMAT(IFLUPT,17)=TRUMAT(IFLUPT,17)+1.
      TRUMAT(IFLUPT,1)=TRUMAT(IFLUPT,1)+UCTAB(IFLUPT)*M
 AVI=AVI*RIMP
 GOTO 60
 65 CONTINUE
C*************************************
C********* ESTABLISH SECUM **********
C*************************************
      IF(J.EQ.0) GO TO 91
      JM=0
      DO 90 JE=1,J
      IF(XSE(JE).EQ."0") GO TO 90
      UFLU=0.
      USYS=0.
```

```
      JH=JH+1
      IF(JH.LE.50) GO TO 84
      PRINT 82
   82 FORMAT("REDIMENSION SECUM, XSECUM, SETAB")
      STOP
   84 XSECUM(JH)=XSE(JE)
      XSE(JE)="0"
      SECUM(JH,4)=SEMAT(JE,5)
      JM=JE+1
      DO 80 JF=JM,J
      IF(XSE(JF).NE.XSECUM(JH)) GO TO 80
      XSE(JF)="0"
      SECUM(JH,4)=SECUM(JH,4)+SEMAT(JF,5)
      UFLU=1.
      IF(SETRU(JF,2).EQ.SETRU(JE,2)) GO TO 80
      USYS=1.
   80 CONTINUE
      SECUM(JH,5)=CEIL(SECUM(JH,4))
      C5Q=SECUM(JH,5)*SEMAT(JE,7)*(1.+PIUP*SEMAT(JE,9))
     IF(USYS.GT.0.) GO TO 89
     IF(UFLU.GT.0.) GO TO 87
      DO 86 JC=1,I
      IF(XTRU(JC,1).NE.SETRU(JE,1)) GO TO 86
      TRUMAT(JC,5)=TRUMAT(JC,5)+C5Q
       SETAB(JH,1)=1.
      SETAB(JH,2)=FLOAT(JC)
      GO TO 90
   86 CONTINUE
   87 DO 88 IQ=1,NSYS
      IF(XSYS(IQ).NE.SETRU(JE,2)) GO TO 88
      SYSMAT(IQ,5)=SYSMAT(IQ,5)+C5Q
       SETAB(JH,1)=2.
       SETAB(JH,2)=FLOAT(IQ)
      GO TO 90
   88 CONTINUE
   89 EQTOT(5)=EQTOT(5)+C5Q
       SETAB(JH,1)=3.
   90 CONTINUE
C*************************************
********* COMPUTE TRU COST *********
C*************************************
 91   CALL DETACH(10,ISTAT, )
      DO 101 IB=1,I
      DO 92 IC=1,7
      TRUMAT(IB,8)=TRUMAT(IB,8)+TRUMAT(IB,IC)
   92 CONTINUE
      TRUMAT(IB,8)=TRUMAT(IB,8)+TRUMAT(IB,20)
  101  CONTINUE
```

```
C*********************************************
C********* COMPUTE SYSTEM COST *************
C*********************************************
      DO 96 IK=1,NSYS
      DO 95 IL=1,I
      IF(XTRU(IL,2).NE.XSYS(IK)) GO TO 95
   SYSMAT(IK,8)=SYSMAT(IK,8)+TRUMAT(IL,20)
      DO 94 IM=1,7
      SYSMAT(IK,IM)=SYSMAT(IK,IM)+TRUMAT(IL,IM)
   94 CONTINUE
   95 CONTINUE
   96 CONTINUE
      DO 99 JN=1,NSYS
       DO 97 JP=1,8
       SYSMAT(JN,13)=SYSMAT(JN,13)+SYSMAT(JN,JP)
   97 CONTINUE
   99 CONTINUE
C**********************************************
C********* COMPUTE ATE COST *********
C**********************************************
      DO 98 IN=1,NSYS
       TOTLSC=TOTLSC+SYSMAT(IN,13)
   98 CONTINUE
        TOTLSC=TOTLSC+EQTOT(5)
C*********************************
C********* PRINT OUTPUT **********
C*********************************
      CALL YADATE(DATE)
      CALL YTIME(ITIME)
      PRINT 112,DATE,ITIME/100000+10000
  112 FORMAT(//"RUN OF ",A8," -- ",I4," HOURS")
      IF(TOTLSC.LT.10**6) GO TO 121
      IF(TOTLSC.LT.10**9) GO TO 117
      PRINT 115,TOTLSC/10**9
  115 FORMAT(//"TOTAL LSC = $",F7.2," BILLION.")
      GO TO 140
  117 PRINT 119,TOTLSC/10**6
  119 FORMAT(//"TOTAL LSC = $",F7.2," MILLION.")
      GO TO 140
  121 PRINT 123,TOTLSC
  123 FORMAT(//"TOTAL LSC = $",F7.0)
C*****************************************************************
C****** KC,KB,KE MUST AGREE WITH DIMENSIONS OF TRUMAT AND XTRU ******
C*****************************************************************
  140 DO 132 KC=1,100
      DO 130 KD=1,20
  130 SORTRU(KC,KD)=TRUMAT(KC,KD)
      DO 131 KE=1,2
  131 SORTXTRU(KC,KE)=XTRU(KC,KE)
```

```
 132 CONTINUE
       KEY(1)=13
       MODE(1)=2
     CALL SORTL(SYSMAT,NSYS,15,KEY,MODE,1,30,1,LINK,XSYS,1,1)
KEY(1)=8
MODE(1)=2
     CALL SORTL(SORTRU,IMAX,20,KEY,MODE,1,100,1,LINK,SORTXTRU,2,1)
 141 PRINT 142
 142 FORMAT(/"DO YOU WANT AN EXPLANATION OF YOUR AVAILABLE ",
&    "OPTIONS?")
     READ 2003,CANS
     IF(CANS.NE."Y") GO TO 150
     PRINT 145
 145 FORMAT(/"OPTION 1 - TOTAL LSC BROKEN OUT BY EQUATION"/
&    "OPTION 2 - ALL SYSTEMS RANKED ON COST"/
&    "OPTION 3 - COST BREAKOUT BY EQUATION FOR A PARTICULAR SYSTEM"/
&    "OPTION 4 - COST RANKING OF TRUS FOR A PARTICULAR SYSTEM"/
&    "OPTION 5 - COST BREAKOUT BY EQUATION FOR A PARTICULAR TRU"/
&    "OPTION 6 - DETAILED SUPPORT EQUIPMENT ANALYSIS"/
&    "OPTION 7 - DETAILED SPARES ANALYSIS"/
&    "OPTION 8 - MAINTENANCE GENERATIONS ANALYSIS"/
&    "OPTION 9 - TRU WORK UNIT CODE/NOUN CROSS-REFERENCE"/
&    "OPTION 10 - STOP PROGRAM")
 150 PRINT 151
 151 FORMAT(/"WHICH OPTION?")
 155 READ:IANS
     IF(IANS.GT.10) GO TO 141
     GO TO (200,250,300,350,400,450,500,550,600,650),IANS

C****************************************
C******** OUTPUT OPTION 1 ************
C****************************************
200   DO 210 MP=1,8
     DO 210 MR=1,NSYS
 210 EQTOT(MP)=EQTOT(MP)+SYSMAT(MR,MP)
     PRINT 335
      PRINT 337,(EQTOT(MS),MS=1,5)
     PRINT 340
      PRINT 345,(EQTOT(MS),MS=6,8)
     GO TO 150

C************************
C*** OUTPUT OPTION 2 ****
C************************
 250 PRINT 260
 260 FORMAT(10X,"SYSTEM",4X,"COST(IN MILLIONS)",4X,
&    "FRACTION OF TOTAL LSC")
     DO 280 IX=1,NSYS
      SYSMAT(IX,14)=SYSMAT(IX,13)/TOTLSC
```

```
      SYSCOST= SYSMAT(IX,13)/10**6
      PRINT 270,XSYS(IX),SYSCOST,SYSMAT(IX,14)
  270 FORMAT(11X,A5,F18.2,F19.2)
  280 CONTINUE
      GO TO 150

C************************
C*** OUTPUT OPTION 3 ****
C************************
  300 PRINT 2006
  310 READ 2004,CANS
      DO 320 IE=1,NSYS
      IF(XSYS(IE).EQ.CANS) GO TO 330
  320 CONTINUE
      PRINT 2002
      GO TO 310
  330 PRINT  335
  335 FORMAT(/"EQUATION",10X,"#1",10X,"#2",10X,"#3",10X,"#4",10X,"#5")
       PRINT 337,(SYSMAT(IE,IG),IG=1,5)
 337   FORMAT(12X,5F12.0//)
      PRINT 340
 340   FORMAT("EQUATION",10X,"#6",10X,"#7",10X,"#8")
       PRINT 345,(SYSMAT(IE,ID),ID=6,8)
 345   FORMAT(12X,3F12.0//)
      GO TO 150

C************************
C*** OUTPUT OPTION 4 ****
C************************
  350 PRINT 2006
  355 READ 2004,CANS
      DO 360 IP=1,NSYS
      IF(XSYS(IP).NE.CANS) GO TO 360

      GO TO 365
  360 CONTINUE
      PRINT 2002
      GO TO 355
  365 PRINT:"HOW MANY TRUS TO BE INCLUDED IN RANKING?"
      READ:IANS
      PRINT 370
  370 FORMAT(49X,"FRACTION OF"/16X,"TRU",12X,"COST",14X,
&     "SYSTEM COST"//)
      PCTG=0.
      IR=0
      DO 380 IY=1,I
      IF(SORTXTRU(IY,2).NE.CANS) GO TO 380
      IR=IR+1
      PCT=SORTRU(IY,8)/SYSMAT(IP,13)
```

```
    PCTG=PCTG+PCT
    PRINT 375,IR,SORTXTRU(IY,1),SORTRU(IY,8),PCT
375 FORMAT(I9,A11,F18.0,F18.2)
    IF(IR.EQ.IANS) GO TO 385
380 CONTINUE
    IF(IR.EQ.IANS) GO TO 385
    PRINT: "THESE ARE ALL THE TRUS IN THIS SYSTEM."
    IANS=IR
385 IPCTG=PCTG*100
    PRINT 390,IANS,IPCTG
390 FORMAT(/"CONTRIBUTION OF TOP",I3,"TRUS=",I3,
&   " PER CENT OF TOTAL SYSTEM COST.")
    PRINT 395,SYSMAT(IP,13)/10**6
395 FORMAT("SYSTEM COST = $",F8.2," MILLION.")
    GO TO 150

C************************
C*** OUTPUT OPTION 5 ****
C************************
400 PRINT 2008
405 READ 2004,CANS
    DO 410 IU=1,I
    IF(SORTXTRU(IU,1).NE.CANS) GO TO 410
    GO TO 415
410 CONTINUE
    PRINT 2002
    GO TO 405
415 PRINT 420
420 FORMAT(/"EQUATION",7X,"#1",12X,"#2",12X,"#3",12X,"#4")
    PRINT 425,(SORTRU(IU,IV),IV=1,4)
425 FORMAT(7X,4F14.0//)
    PRINT 430
430  FORMAT("EQUATION",7X,"#5",12X,"#6",12X,"#7",12X,"#8")
     PRINT 435,(SORTRU(IU,JL),JL=5,7),SORTRU(IU,20)
435 FORMAT(7X,4F14.0)
    GO TO 150

C************************
C*** OUTPUT OPTION 6 ****
C************************
450 CONTINUE
    PRINT:"    COL 1 - SE IDENTIFICATION"
    PRINT:"    COL 2 - FRACTIONAL SE RQMT-BASE (COMPUTED)"
    PRINT:"    COL 3 - TOTAL SE RQMT-BASE (INTEGERIZED)"
    PRINT:"    COL 4 - FRACTIONAL SE RQMT-DEPOT (COMPUTED)"
    PRINT:"    COL 5 - TOTAL SE RQMT-DEPOT (INTEGERIZED)"
    PRINT 460
460 FORMAT(/6X,"1",19X,"2",9X,"3",12X,"4",9X,"5"//)
    DO 480 JK=1,JH
```

```
      PRINT 470,XSECUM(JK),(SECUM(JK,JR),JR=2,5)
 470  FORMAT(1X,A20,F8.2,F9.0,F14.2,F9.0)
 480  CONTINUE
      GO TO 150

C     ***************************************
C     ********** OUTPUT OPTION 7 *********
C     ***************************************
 500  PRINT 510
 510  FORMAT(24X,"TRUS"//4X,"WUC",5X,"BMDMEAN",6X,"XBO",6X,
&      "AV",9X,"STK",6X,"BPIPE",2X,"TOTCOND"//)
     DO 530 MU=1,I
      PRINT 520,XTRU(MU,1),(TRUMAT(MU,MX),MX=14,19)
520  FORMAT(3X,A5,2F10.2,F10.4,3F10.0)
530  CONTINUE
     PRINT 540,AVI
540  FORMAT(1X//11X,"SYSTEM AVAILABILITY= ",F5.3)
     GO TO 150
C******************************
C******** OUTPUT OPTION 8 *******
C*********************************
 550  PRINT 560
 560  FORMAT(31X,"PEAK",25X,"TOTAL"/20X,"PEAK",5X,"OFF-EQUIP",10X,
&     "TOTAL",5X,"OFF-EQUIP"/7X,"WUC",10X,"GENS",7X,"GENS",14X,"GENS",
&     8X,"GENS"//)
      DO 570 MV=1,I
      PRINT 565,XTRU(MV,1),(TRUMAT(MV,MY),MY=9,12)
 565  FORMAT(6X,A5,6X,F8.2,F11.2,F18.2,F12.2)
 570  CONTINUE
      GO TO 150

C**************************************
C******* OUTPUT OPTION 9 *************
C**************************************
 600  PRINT 610
 610  FORMAT(/3X,"WUC",7X,"NOUN"//)
      DO 625 JZ=1,I
      PRINT 620,XTRU(JZ,1),TRUNOUN(JZ)
 620  FORMAT(2X,A5,3X,A60)
 625  CONTINUE
      GO TO 150

2002 FORMAT("IMPROPER IDENTIFICATION--RETYPE")
2003 FORMAT(A1)
2004 FORMAT(A5)
2006 FORMAT("SYSTEM IDENTIFICATION?")
2008 FORMAT("TRU IDENTIFICATION?")

```

```
  650 STOP
      END
C*********************************************************
C********* FUNCTION TO INTEGERIZE ROUNDING UP ***********
C*********************************************************
      FUNCTION CEIL(X)
      Y=AINT(X)
      Z=X-Y
      IF(Z),,1
      CEIL=X
      RETURN
    1 CEIL=Y+1.
      RETURN
      END
C**********************************************************************
 SUBROUTINE SORTL(A,NREC,NWPR,KEY,MODE,NKEY,ID,IP,LINK,CMAT,ICCOL,ICIND)
C**********************************************************************
C A GENERAL PURPOSE SORTING SUBROUTINE USING LINK ADDRESSING
C:A             ARAAY OF SIZE NREC BY NWPR WHOSE ROWS COMPRISE
C:              THE DATA RECORDS TO  BE SORTED
C:
C:NREC          NUMBER OF RECORDS=NUMBER OF ROWS OF A
C:
C:NWPR          NUMBER OF WORDS/RECORD=NUMBER OF COLUMNS OF A
C:
C:KEY           ARRAY OF SIZE NKEY WHOSE ELEMENTS ARE POINTERS TO
C:              THE COLUMNS OF A CONTAINING THE SORT KEYS
C:
C:MODE          ARRAY OF SIZE NKEY WHOSE ELEMENTS DEFINE THE
C:              ORDERING RELATION PLACED ON EACH KEY
C:              -2 INCREASING,UNSIGNED ORDER
C:              -1 INCREASING,SIGNED ORDER
C:              +1 DECREASING,UNSIGNED ORDER
C:              +2 DECREASING,SIGNED ORDER
C:
C:NKEY          NUMBER OF KEYS=SIZE OF ARRAYS KEY AND MODE
C:
C:ID            FIRST DIMENSION OF A IN THE PROGRAM CALLING UNIT
C:
C:IP            IF IP=0 THE RECORDS REMAIN IN THEIR ORIGINAL LOCATION,
C:              OTHERWISE, THE RECORDS ARE MOVED INTO THE DESIRED
C:              ORDER FOLLOWING THE SORT
C:
C:LINK          OUTPUT ARRAY OF SIZE NREC WHOSE ELEMENTS ARE
C:              POINTERS TO THE RECORDS IN A IN SORTED SEQUENCE
C:
C:CMAT          CHARACTER ARRAY OF SIZE NREC BY ICCOL WHOSE ROWS
C:              ARE MOVED IN CONJUNCTION WITH THE ROWS OF ARRAY A
```

```
C:
C:ICCOL      NUMBER OF COLUMNS OF CHARACTER VALUES IN ARRAY CMAT;
C:           EACH VALUE HAS 5 CHARACTERS
C:
C:ICIND      "FLAG" VALUE FOR SORTING CMAT;
C:           =0 DO NOT OPERATE ON CMAT
C:           NOT=0 REARRANGE THE VALUES IN CMAT
      DIMENSION A(ID,NUPR),KEY(NKEY),MODE(NKEY),LINK(NREC)
      INTEGER A,TEMP(100)
      CHARACTER CTEMP*5(20)
      CHARACTER CMAT*5(ID,ICCOL)
      LOGICAL EQV,P,Q
      EQV(P,Q) = (P.AND.Q).OR.(.NOT.(P.OR.Q))
      NROW=NREC
      NCOL=NUPR
C
C INITIALIZE LINKS
C
      DO 10 I=1,NROW
   10 LINK(I)=I
      IF (NROW.EQ.1) RETURN
C
C FORM INITIAL INCREMENT
C
      M1=(NROW+5)/6
      M=1
   20 M=2*M
      IF (M.LT.M1) GO TO 20
      M=M-1
C
C BEGIN NEXT SORT PASS
C
   30 M1=M+1
      DO 100 J=M1,NROW
      LJ=LINK(J)
      I=J-M
C
C COMPARE KEYS IN RECORDS LINK(I) AND LINK(J)
C
   40 LI=LINK(I)
      DO 50 L=1,NKEY
      K=KEY(L)
      KI=A(LI,K)
      KJ=A(LJ,K)
      IF (EQV(KI.LT.0,KJ.GE.0)) GO TO 60
      IF (KI.NE.KJ) GO TO 70
   50 CONTINUE
   60 IF(EQV(KI.LT.0,KJ.GE.0))GOTO 90
      GO TO 80
```

```
   70 IF (EQV(KI.LT.KJ,MODE(L).LT.0)) GO TO 90
C
C RECORDS LINK(II), LINK(J) OUT OF ORDER
C
   80 II = I+M
      LINK(II)=LINK(I)
      I=I-M
      IF (I.GT.0) GO TO 40
C
C  RECORDS LINK(I), LINK(J) ALREADY IN ORDER
C
   90 II = I+M
      LINK(II)=LJ
  100 CONTINUE
C
C END OF SORT PASS
C
      IF (M.GT.15) M=M/2
      M=M/2
      IF (M.NE.0) GO TO 30
C
C END OF SORT, TEST WHICH OPTION
C
      IF (IP.EQ.0) RETURN
C
C REARRANGE RECORDS IN A ACCORDING TO LINK
C
      DO 150 I=1,NROW
      IF (LINK(I).EQ.I) GO TO 150
      DO 110 K=1,NCOL
      TEMP(K)=A(I,K)
  110 CONTINUE
      IF(ICIND.EQ.0)  GO TO 117
      DO 115 I115=1,ICCOL
      CTEMP(I115)=CMAT(I,I115)
  115 CONTINUE
  117 CONTINUE
      J=I
C
C  BEGIN CYCLE
C
  120 LJ=LINK(J)
      DO 130 K=1,NCOL
  130 A(J,K) =A(LJ,K)
      IF(ICIND.EQ.0)  GO TO 137
      DO 135 I135=1,ICCOL
      CMAT(J,I135)=CMAT(LJ,I135)
  135 CONTINUE
  137 CONTINUE
```

```
      LINK(J)=J
      J=LJ
      IF (LINK(J).NE.I) GO TO 120
C
C END OF CYCLE
C
      DO 140 K=1,NCOL
  140 A(J,K) =TEMP(K)
      IF(ICIND.EQ.0)  GO TO 147
      DO 145 I145=1,ICCOL
      CMAT(J,I145)=CTEMP(I145)
  145 CONTINUE
  147 CONTINUE
      LINK(J)=J
  150 CONTINUE
      RETURN
      END
```

APPENDIX G

OSCATE MODEL OUTPUT FOR THE TAPE READER

```
RUN OSCATE#TAPEREAD"10"
SOURCE LINE   5790
<W>1470 EQUALITY OR NON-EQUALITY COMPARISON MAY NOT BE MEANINGFUL I
N LOGICAL IF EXPRESSIONS


RUN OF 05/20/80 -- 1137 HOURS


TOTAL LSC = $   1.29 MILLION.

DO YOU WANT AN EXPLANATION OF YOUR AVAILABLE OPTIONS?
=Y

OPTION 1 - TOTAL LSC BROKEN OUT BY EQUATION
OPTION 2 - ALL SYSTEMS RANKED ON COST
OPTION 3 - COST BREAKOUT BY EQUATION FOR A PARTICULAR SYSTEM
OPTION 4 - COST RANKING OF TRUS FOR A PARTICULAR SYSTEM
OPTION 5 - COST BREAKOUT BY EQUATION FOR A PARTICULAR TRU
OPTION 6 - DETAILED SUPPORT EQUIPMENT ANALYSIS
OPTION 7 - DETAILED SPARES ANALYSIS
OPTION 8 - MAINTENANCE GENERATIONS ANALYSIS
OPTION 9 - TRU WORK UNIT CODE/NOUN CROSS-REFERENCE
OPTION 10 - STOP PROGRAM

WHICH OPTION?
=1

EQUATION         #1         #2         #3         #4         #5
              21364.     72970.     16142.     527039.    625590.

EQUATION         #6         #7         #8
                  0.     26800.         0.


WHICH OPTION?
=
```

```
WHICH OPTION?
=4
SYSTEM IDENTIFICATION?
=PAL00
HOW MANY TRUS TO BE INCLUDED IN RANKING?
=18
```

	TRU	COST	FRACTION OF SYSTEM COST
1	PALCB	124944.	0.10
2	PALNO	102859.	0.08
3	PALJA	81771.	0.06
4	PALJB	62021.	0.05
5	PALMO	41334.	0.03
6	PALJE	29964.	0.02
7	PALLO	29497.	0.02
8	PALJC	19327.	0.01
9	PALFO	14868.	0.01
10	PALCQ	13379.	0.01
11	PALCP	9950.	0.01
12	PALKO	6253.	0.00
13	PALCL	5194.	0.00
14	PALCG	5194.	0.00
15	PALRO	5194.	0.00
16	PALGO	5194.	0.00
17	PALPO	5194.	0.00
18	PALCN	5095.	0.00

```
CONTRIBUTION OF TOP 18TRUS= 43 PER CENT OF TOTAL SYSTEM COST.
SYSTEM COST = $    1.29 MILLION.

WHICH OPTION?
=
```

7

WUC	DNBMEAN	TRUS XBO	AV	STK	DPIPE	TOTCOND
PALCB	0.02	0.02	0.9964	0.	1.	0.
PALCG	0.	0.	1.0000	0.	0.	0.
PALCL	0.	0.	1.0000	0.	0.	0.
PALCN	0.	0.	1.0000	0.	0.	0.
PALCP	0.	0.	1.0000	0.	0.	0.
PALCQ	0.03	0.03	0.9948	0.	1.	1.
PALFO	0.	0.	1.0000	0.	0.	0.
PALGO	0.	0.	1.0000	0.	0.	0.
PALJA	0.01	0.01	0.9989	0.	1.	0.
PALJB	0.	0.	1.0000	0.	0.	0.
PALJC	0.	0.	1.0000	0.	0.	0.
PALJE	0.01	0.01	0.9979	0.	1.	0.
PALKO	0.00	0.00	0.9991	0.	1.	0.
PALLO	0.00	0.00	0.9995	0.	1.	0.
PALMO	0.02	0.02	0.9958	0.	1.	0.
PALNO	0.01	0.01	0.9989	0.	1.	0.
PALPO	0.	0.	1.0000	0.	0.	0.
PALRO	0.	0.	1.0000	0.	0.	0.

SYSTEM AVAILABILITY= 0.981

WHICH OPTION?
=

8

WUC	PEAK GENS	PEAK OFF-EQUIP GENS	TOTAL GENS	TOTAL OFF-EQUIP GENS
PALCB	0.11	0.09	7.88	6.77
PALCG	0.01	0.	0.98	0.
PALCL	0.01	0.	0.98	0.
PALCN	0.05	0.	3.94	0.
PALCP	0.13	0.	9.85	0.
PALCQ	0.13	0.13	9.85	9.65
PALFO	0.03	0.	1.97	0.
PALGO	0.01	0.	0.98	0.
PALJA	0.03	0.03	1.97	1.97
PALJB	0.03	0.	1.97	0.
PALJC	0.05	0.	3.94	0.
PALJE	0.05	0.05	3.94	3.94
PALKO	0.03	0.02	1.97	1.69
PALLO	0.01	0.01	0.98	0.98
PALMO	0.11	0.11	7.88	7.88
PALNO	0.03	0.03	1.97	1.97
PALPO	0.01	0.	0.98	0.
PALRO	0.01	0.	0.98	0.

WHICH OPTION?
=

9

```
 WUC        NOUN

PALCB   4920-00-463-1096DQ__READER_PUNCHED_TAPE
PALCG   4920-00-166-8990DQ__HUD
PALCL   5930-00-413-0661EW__SWITCH
PALCN   5895-00-420-3220ZR__MOTOR_DRIVER
PALCP   6625-00-760-7796____AMP._PHOTOCELL
PALCQ   6625-00-450-2020DQ__MOTOR_SEQ._CONTROL
PALFO   4920-00-567-7853DQ__CABLE_SPECIAL_PURP.
PALGO   4920-00-469-9160DQ__CONTROLLER_TR
PALJA   4920-00-410-6914DQ__MODULE_CONTROLLER
PALJB   4920-00-410-6915DQ__MODULE_LINE_DRIVER
PALJC   4920-00-410-6916DQ__MODULE_LINE_RECEIV.
PALJE   4920-00-152-2273DQ__MODULE
PALKO   4920-00-464-3025DQ__LINE_DRIVE_CIRC.
PALLO   4920-00-464-3026DQ__CONTROL_AMP._CIRC.
PALMO   4920-00-464-3027DQ__DECODE_CIRCUIT
PALNO   4920-00-494-8631DQ__LAMP_DRIVER_CIRCUIT
PALPO   4920-00-494-8632DQ__LAMP_DRIVER_BUFFER
PALRO   4920-00-195-4154DQ__CABLE_ASSY.

WHICH OPTION?
=10

*
```

APPENDIX H

OSCATE MODEL OUTPUT FOR THE CADC TEST STATION

```
 RUN OSCATE#CADC"10"
SOURCE LINE   5790
<W>1470 EQUALITY OR NON-EQUALITY COMPARISON MAY NOT BE MEANINGFUL I
N LOGICAL IF EXPRESSIONS


RUN OF 05/05/80 -- 0713 HOURS


TOTAL LSC = $944187.

DO YOU WANT AN EXPLANATION OF YOUR AVAILABLE OPTIONS?
=YES

OPTION 1 - TOTAL LSC BROKEN OUT BY EQUATION
OPTION 2 - ALL SYSTEMS RANKED ON COST
OPTION 3 - COST BREAKOUT BY EQUATION FOR A PARTICULAR SYSTEM
OPTION 4 - COST RANKING OF TRUS FOR A PARTICULAR SYSTEM
OPTION 5 - COST BREAKOUT BY EQUATION FOR A PARTICULAR TRU
OPTION 6 - DETAILED SUPPORT EQUIPMENT ANALYSIS
OPTION 7 - DETAILED SPARES ANALYSIS
OPTION 8 - MAINTENANCE GENERATIONS ANALYSIS
OPTION 9 - TRU WORK UNIT CODE/NOUN CROSS-REFERENCE
OPTION 10 - STOP PROGRAM

WHICH OPTION?
=1

EQUATION          #1         #2         #3         #4          #5
                8707.     30583.     1021.     396643.     157416.

EQUATION          #6         #7         #8
                   0.    197174.    152643.


WHICH OPTION?
=
```

```
 4
SYSTEM IDENTIFICATION?
=PAJOO
HOW MANY TRUS TO BE INCLUDED IN RANKING?
=26
```

	TRU	COST	FRACTION OF SYSTEM COST
1	PAJCA	102019.	0.11
2	PAJLA	97861.	0.10
3	PAJBB	65883.	0.07
4	PAJHC	33583.	0.04
5	PAJBA	14350.	0.02
6	PAJHA	11181.	0.01
7	PAJJB	8367.	0.01
8	PAJJC	8367.	0.01
9	PAJHF	5897.	0.01
10	PAJHB	5567.	0.01
11	PAJGA	5236.	0.01
12	PAJKF	5236.	0.01
13	PAJDD	5236.	0.01
14	PAJKE	5071.	0.01
15	PAJKB	5071.	0.01
16	PAJTO	5071.	0.01
17	PAJDB	5071.	0.01
18	PAJHG	5071.	0.01
19	PAJLC	5071.	0.01
20	PAJDF	5071.	0.01
21	PAJKA	5071.	0.01
22	PAJHE	5071.	0.01
23	PAJDA	5071.	0.01
24	PAJDE	5071.	0.01
25	PAJLB	5071.	0.01
26	PAJCB	5071.	0.01

```
CONTRIBUTION OF TOP 26TRUS= 46 PER CENT OF TOTAL SYSTEM COST.
SYSTEM COST = $     0.94 MILLION.

WHICH OPTION?
=
```

7

TRUS

UUC	DMDMEAN	XBG	AV	STK	BPIPE	TOTCOND
PAJBA	0.	0.	1.0000	0.	0.	0.
PAJBB	0.00	0.00	0.9988	0.	1.	0.
PAJCA	0.	0.	1.0000	0.	0.	0.
PAJCB	0.	0.	1.0000	0.	0.	0.
PAJDA	0.	0.	1.0000	0.	0.	0.
PAJDB	0.	0.	1.0000	0.	0.	0.
PAJDD	0.	0.	1.0000	0.	0.	0.
PAJDE	0.	0.	1.0000	0.	0.	0.
PAJDF	0.	0.	1.0000	0.	0.	0.
PAJGA	0.	0.	1.0000	0.	0.	0.
PAJHA	0.01	0.01	0.9946	0.	1.	0.
PAJHB	0.	0.	1.0000	0.	0.	0.
PAJHC	0.00	0.00	0.9972	0.	1.	0.
PAJHE	0.	0.	1.0000	0.	0.	0.
PAJHF	0.	0.	1.0000	0.	0.	0.
PAJHG	0.	0.	1.0000	0.	0.	0.
PAJJB	0.	0.	1.0000	0.	0.	0.
PAJJC	0.	0.	1.0000	0.	0.	0.
PAJKA	0.	0.	1.0000	0.	0.	0.
PAJKB	0.	0.	1.0000	0.	0.	0.
PAJKE	0.	0.	1.0000	0.	0.	0.
PAJKF	0.	0.	1.0000	0.	0.	0.
PAJLA	0.	0.	1.0000	0.	0.	0.
PAJLB	0.	0.	1.0000	0.	0.	0.
PAJLC	0.	0.	1.0000	0.	0.	0.
PAJTO	0.	0.	1.0000	0.	0.	0.

SYSTEM AVAILABILITY= 0.991

WHICH OPTION?

=

8

WUC	PEAK GENS	PEAK OFF-EQUIP GENS	TOTAL GENS	TOTAL OFF-EQUIP GENS
PAJBA	0.01	0.	0.69	0.
PAJBB	0.03	0.01	2.75	0.69
PAJCA	0.03	0.	2.75	0.
PAJCB	0.01	0.	0.69	0.
PAJDA	0.01	0.	0.69	0.
PAJDB	0.01	0.	0.69	0.
PAJDD	0.01	0.	1.38	0.
PAJDE	0.01	0.	0.69	0.
PAJDF	0.01	0.	0.69	0.
PAJGA	0.01	0.	1.38	0.
PAJHA	0.05	0.03	5.50	2.97
PAJHB	0.03	0.	2.75	0.
PAJHC	0.03	0.01	2.75	1.54
PAJHE	0.01	0.	0.69	0.
PAJHF	0.04	0.	4.13	0.
PAJHG	0.01	0.	0.69	0.
PAJJB	0.01	0.	0.69	0.
PAJJC	0.01	0.	0.69	0.
PAJKA	0.01	0.	0.69	0.
PAJKB	0.01	0.	0.69	0.
PAJKE	0.01	0.	0.69	0.
PAJKF	0.01	0.	1.38	0.
PAJLA	0.01	0.	0.69	0.
PAJLB	0.01	0.	0.69	0.
PAJLC	0.01	0.	0.69	0.
PAJTG	0.01	0.	0.69	0.

WHICH OPTION?

9

```
 UUC        NOUN

PAJBA   4920-00-342-0844DQ__OSCILLATOR
PAJBB   4920-00-109-8333DQ__POWER_SUPPLY
PAJCA   4920-00-136-0022DQ__ANGLE_POS._IND.
PAJCB   4920-00-135-5408DQ__CIRC._CARD_PWR._SUPP.
PAJDA   4920-00-432-5330DQ__RELAY_DRIVER
PAJDB   6625-00-403-0103DQ__DEMODULATOR
PAJDD   4920-00-449-2888DQ__COUNTER
PAJDE   4920-00-449-2887DQ__DECODER
PAJDF   4920-00-242-8715____SWITCH_QUAD.
PAJGA   4140-01-043-5035____BLOWER_MOTOR
PAJHA   4920-00-192-1109DQ__COMPARATOR_DIGITAL
PAJHB   4920-00-136-0124DQ__COMPAR._BOARD
PAJHC   4920-00-136-0128DQ__PWR._SUPP._PC_BOARD
PAJHE   4920-00-136-0127DQ__RELAY_BOARD_PC
PAJHF   4920-00-136-0125DQ__STORAGE_BOARD_PC
PAJHG   4920-00-192-1012DQ__GATE_RESET_BOARD_PC
PAJJB   6625-00-167-9581____10K_DECADE
PAJJC   6625-00-167-9582____STD._DECADE
PAJKA   4920-00-450-4376DQ__RESISTOR_MODULE
PAJKB   4920-00-401-5467DQ__DRIVER_MODULE
PAJKE   4920-00-722-7899DQ__BOARD_ASSY._DE
PAJKF   4920-00-726-2262DQ__BOARD_ASSY._DE
PAJLA   4920-00-450-6077DQ__PHOTO_BLK._TR
PAJLB   4920-00-116-4167DQ__CONT_UNIT_CU80
PAJLC   4920-00-135-5339DQ__MODULE
PAJTG   4920-01-046-1604BJ__FIXT._HOLD_CADC

WHICH OPTION?
=10

*
```

SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. Air Force Logistics Command. Component Support Cost System (CSCS) Functional Description. FD-HAF-D-78-08-1. Wright Patterson AFB OH: HQ AFLC/LOLR. 30June 1979.

2. Bell, Archie C., and Captain Daniel P. Turney, USAF. "A Summary and Analysis of the Initial Application of Life Cycle Costing Techniques to a Major Weapon System Acquisition." Unpublished masters thesis, LSSR 35-78B, AFIT/SL, Wright-Patterson AFB OH, September 1978.

3. Betaque, Norman E., and Marco R. Fiorello. Aircraft System Operating and Support Costs: Guidelines for Analysis. Washington: Logistics Management Institute, 1977.

4. Budnick, Frank S., Richard Mojena, and Thomas E. Vollmann. Principles of Operations Research for Management. Homewood Illinois: Richard D. Irwin, Inc., 1977.

5. Concepts and Analysis Directorate, Acquisition Logistics Division, Air Force Logistics Command. Logistics Support Cost Model User's Handbook. ALD/XRSC, Wright-Patterson AFB OH, August 1976.

6. Criscimagna, Major Ned H., USAF, "The Yesterday, Today, and Tomorrow of Integrated Logistics Support," Defense Management Journal, October 1977, pp 59-63.

7. Culp, Major Joseph R., USAF, and Captain Steven D. Novy, USAF. "Application of Life Cycle Costing Principles to Less than Major Programs." Unpublished master's thesis, LSSR 6-78B, AFIT/SL, Wright-Patterson AFB OH, September 1978.

8. Dover, Captain Lawrence E., USAF, and Captain Billie E. Oswald, Jr., USAF. "A Summary and Analysis of Selected Life Cycle Costing Techniques and Models." Unpublished master's thesis, LSSR 18-74B, AFIT/LS, Wright-Patterson AFB OH, August 1974.

9. Drobot, Captain Nicholas J., USAF, and Captain Martin H. Johnson, USAF. "A Study of Two Avionics Life Cycle Cost Models and Their Applicability in the Communications-Electronics-Meteorological Environment". Unpublished master's thesis, AFIT/GSM/SM/79S-5, Wright-Patterson AFB OH, September 1979. ADA076981.

10. Gibson, John D. S. Understanding and Evaluating Life Cycle Cost Models. 2nd ed. Directorate of Cost Analysis, Comptroller, Aeronautical Systems Division, Wright-Patterson AFB OH, March 1977.

11. __________. Life Cycle Cost Management Guidance for Program Managers. 4th ed. Directorate of Cost Analysis, Comptroller, Aeronautical Systems Division, Wright-Patterson AFB OH, July 1978.

12. Guerra, Joel A., Captain Andrew J. Lesko, USAF, and Colonel Jose G. Periera, FAV. "Operating and Support Cost Model for Avionics Automatic Test Equipment." Unpublished master's thesis, LSSR 21-79B, AFIT/LS, Wright-Patterson AFB OH, September 1979.

13. Hill, Colonel Vaughn E., USAF, and Colonel Paul L. Martin, Jr., USAF. "Life Cycle Costing: Its Promises and Problems." Unpublished research report No. 5995, Air War College, Maxwell AFB AL, 1976.

14. Jeffreys, Captain Richard T., USAF, and Major Carver L. Sears, USAF. "A Logistics Support Cost Analysis of the Advanced Aerial Refueling Boom." Unpublished master's thesis, GSM/SM/765-13, Wright-Patterson AFB OH, September 1976. AD A032274.

15. Light, Stephen P. "The Guided Missile Frigate: New Technology for a New Era." Defense Management Journal, January 1977, pp 38-44.

16. Logistics Management Institute. Management Procedures for Evaluating Requirements and Relationships Between AGE/ATE and System Acquisition. Logistics Management Institute Report No. Task 72-1. Rev. Phase I, Washington, December 1972.

17. Recktenwalt, Thomas J. LO (VAMOSC), Headquarters Air Force Logistics Command, Wright-Patterson AFB OH. Personal Interview. 02 May 1980.

18. Rone, SMSgt J., USAF. "Variable Cost Study (Cost to Add, Maintain and Delete)". AFLMC Report No. 761138-3, Air Force Logistics Management Center, Gunter AFS AL, June 1979.

19. San Antonio Air Logistics Center/MMI. F/FB-111 Avionics Intermediate Shop Test Stations. 20 Year Cost Analysis, Kelly AFB TX, 4 December 1979.

20. Scheffel, Robert L. MATPC, San Antonio Air Logistics Center, Kelly AFB TX. Telephone Interview. 24 April 1980.

21. Sepp, O.W. Deputy Director, Support Equipment SPO, Deputy for Aeronautical Equipment, HQ AFSC/ASD. Letter, subject: Verification/Validation of Computer Models, to AFIT/ENS/LSG, 13 November 1978.

22. Solis, Orlando F., San Antonio Air Logistics Center/DSPP, Kelly AFB TX. Telephone Interview. 09 April 1980.

23. U.S. Department of the Air Force. Air Force Logistics Command. Automatic Test Equipment Acquisition Planning Guide, SAAMA, Kelly AFB TX: January 1974.

24. U.S. Department of Defense. Defense Supply Agency. Office of the Assistant Director. Plans, Programs and Systems Analysis Division. Compendium of Inventory Control Point Management Information. Washington: Government Printing Office, November 1974.

25. Wolfe, Robert L. LOMRR, Headquarters Air Force Logistics Command, Wright-Patterson AFB, OH. Personal Interview. 15 February 1980.

B. DIRECTIVES CITED

26. U.S. Department of the Air Force. Acquisition of Support Equipment. AFR 800-12. Washington: Government Printing Office, 1974.

27. ________. Acquisition Program Management. AFR 800-2. Washington: Government Printing Office, 1977.

28. ________. AF Metrology and Calibration Program. T.O. 00-20-14. Washington: Government Printing Office. 15 February 1980.

29. ________. AFLC Automated Reports Management System (P005C). AFLCM 171-280. Washington: Government Printing Office. 22 May 1972.

30. ________. AFLC Cost and Planning Factors. AFLCR 173-10. Washington: Government Printing Office. 27 October 1978.

31. ________. AFLC List of Recurring Reports. AFLCP 178-5. Washington: Government Printing Office. 21 November 1979.

32. ________. Age Acquisition Management. AFSCR/AFLCR 800-5. Washington: Government Printing Office, May 1971.

33. ________. Air Force Manpower Standards. AFM 26-3. Washington: Government Printing Office. 01 January 1973.

34. ________. Airlift Service. Air Force Industrial Fund. AFR 170-12. Washington: Government Printing Office. 26 May 1978.

35. ________. Automatic Data Processing Systems and Procedures Command ADPE Performance Management/Interface System (P040E). AFLCM 171-351. Washington: Government Printing Office. 27 June 1979.

36. ________. Base Level Personnel System: E300/VK/AC/AE/EW(PA) Computer Operation Manual. AFM 171-130. Washington: Government Printing Office. 01 January 1980.

37. ________. Base Level Personnel Systems Civilian Personnel. AFM 30-130. Washington: Government Printing Office. 01 January 1980.

38. ________. Central Air Data Computer Test Station. TO 33D3-24-18-2. Washington: Government Printing Office. 27 June 1969.

39. ________. Class V Modification Management. AFLCR/AFSCR 57-3. Washington: Government Printing Office. 30 December 1970.

40. ________. Computation of Requirements for Equipment Type Items. AFLCM 57-2. Washington: Government Printing Office. 26 January 1977.

41. ________. Data Elements and Codes. AFM 300-4. Washington: Government Printing Office. 19 March 1980.

42. ________. Data Systems Authorization Directory. AFP 300-16. Washington: Government Printing Office. January 1977.

43. ________. Depot Maintenance Service Air Force Industrial Fund Financial Procedures. AFLCR 170-10. Washington: Government Printing Office. 28 June 1979.

44. ________. Depot Maintenance Service/Air Force Industrial Fund-Local. AFLCM 171-347. Washington: Government Printing Office. 29 April 1978.

45. ________. Equipment Item Requirements Computations (D039). AFLCM 171-250. Washington: Government Printing Office. 23 June 1975.

46. ________. Equipment Numbers to Technical Order Numbers. TO 0-4-6-2. Washington: Government Printing Office. 15 September 1979.

47. ________. Integrated Logistics Support (ILS) Program for Systems and Equipment. AFR 800-8. Washington: Government Printing Office, July 1972.

48. ________. Joint Regulation Governing the Use and Application of Uniform Source Maintenance and Recoverability Codes. AFR 66-45. Washington: Government Printing Office. 22 June 1971.

49. ________. Life Cycle Cost Management Program. AFR 800-11. Washington: Government Printing Office, 1978.

50. ________. The Maintenance Data Collection System. TO 00-20-2. Washington: Government Printing Office. 1 December 1979.

51. ________. Management and Control of Internation Requirements. AFR 178-7. Washington: Government Printing Office. 29 November 1976.

52. ________. Management and Control of Information Requirements. AFR 178-7, AFLC Supplement 1. Washington: Government Printing Office. 13 August 1979.

53. ________. Management of Automated Test Systems. AFLCR 66-37. Washington: Government Printing Office, March 1976.

54. ________. Management of Items Subject to Repair (MISTR). AFLCR 65-12. Washington: Government Printing Office. 02 August 1978.

55. ________. MISTR Requirements Scheduling and Analysis (G019C). AFLCR 171-296. Washington: Government Printing Office. 3 November 1975.

56. ________. Master Material Support Record (D049). AFLCR 65-1. Washington: Government Printing Office. 07 October 1977.

57. ________. Master Material Support Record (D049). AFLCR 171-73. Washington: Government Printing Office.

58. ________. PME Interval, Labor Estimate, Calibration and Repair Technical Order Reference Guide and Work Unit Code Manual. TO 33K-1-100. Washington: Government Printing Office. 1 January 1980.

59. ________. Product Improvement Program for Operational Equipment. AFR 66-30. Washington: Government Printing Office. 10 January 1977.

60. ________. Product Performance. AFR 66-15. Washington: Government Printing Office. 01 July 1978.

61. ________. Product Performance System (D056). AFLCM 171-45. Washington: Government Printing Office. 21 April 1971.

62. ________. Punched Tape Reader Type AN/GYQ-9-11. TO 33D7-12-28-1. Washington: Government Printing Office. 2 January 1970.

63. ________. Recoverable Consumption Item Requirements System (D041). AFLCR 171-4. Washington: Government Printing Office. 26 February 1979.

64. ________. Source, Maintenance, and Recoverability Coding of Air Force Weapons, Systems, and Equipment. TO 00-25-195. Washington: Government Printing Office. 1 March 1977.

65. ________. Test and Associated Equipment Technical
r rs. TO 0-1-33-( ). Washington: Government
nting Office. 1 June 1979.

66. ________. USAF Budget Manual, Policies and Procedures. AFM 172-1. Washington: Government Printing Office. 15 March 1974.

67. ________. USAF Supply Manual. AFM 67-1. Washington: Government Printing Office. 16 June 1975.

68. ________. Central Air Data Computer Test Station. TO 33D3-24-18-2. Washington: Government Printing Office. 27 June 1969.

69. ________. Hq San Antonia Air Logistics Center (AFLC). Data Automation, Assignment of Automated Data Processing Systems within San Antonio ALC. SA-ALC/KAFB Pamphlet 300-2. SA-ALC, Kelly AFB TX: February 1977.

70. U.S. Department of Defense. Directorate of Defense Research and Engineering. Design to Cost. DODD 5000.28. Washington: Government Printing Office. 23 May 1975.

71. ________. Directorate of Defense Research and Engineering. Economic Analysis and Program Evaluation for Resource Management. DODD 7041.3. Washington: Government Printing Office. 18 October 1972.

72. ________. Directorate of Defense Research and Engineering. Major Systems Acquisition Process. DODD 5000.1. Washington: Government Printing Office. 18 January 1977.

73. ________. Directorate of Defense Research and Engineering. Major Systems Acquisition Process. DODD 5000.2. Washington: Government Printing Office. 18 January 1977.

74. ________. Office of the Assistant Secretary (Installations and Logistics). Defense Inactive Item Program. DOD 4130.32M. Washington: Government Printing Office. March 1975.

75. ________. Office of the Assistant Secretary (Installations and Logistics). Federal Catalog System Policy Manual. DOD 4130.2M. Washington: Government Printing Office. March 1975.

C. RELATED SOURCES

Bennet, Doctor John J. "Industry Feedback on Life Cycle Cost." Defense Management Journal, October 1976, p 38.

Emery, C. William. Business Research Methods. Homewood IL: Richard D. Irwin, Inc., 1976.

Hart, Senator Gary W. "DOD Should Share Its Experience In Life Cycle Costing." Defense Management Journal, January 1978, pp 16-18.

Novak, Captain Frederick V., USAF, and Major Henry Winters, Jr., USAF. "Automatic Test Equipment Software Life Cycle Cost Simulation Model Validation." Unpublished master's thesis, LSSR 16-78A, AFIT/SL, Wright-Patterson AFB OH, June 1978.

Staats, Elmer B. "Acquisition Management Needs Realistic Forecasting to Close the Confidence Gap." Defense Management Journal, April 1974.